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ABSTRACT

These six learning modules were developed for Lake Michigan College's Basic Science Training Program, a workshop to develop good study skills while reviewing basic science. The first module, which was designed to provide students with the necessary skills to study efficiently, covers the following topics: time management; an overview of a study method that focuses on the class syllabus, reading assignments, lecture note taking, textbook note taking, and self-quizing; laboratory work and tests; and suggestions for test preparation and test taking. The second module teaches students to derive the meaning of new words through their understanding of root words, prefixes, and suffixes. The third module teaches students about the basic metric units of length, volume, mass, and temperature, enabling them to perform quantitative measurements and estimates using the metric system. The fourth module imparts the knowledge and skill necessary for the proper use of the microscope, looking at the history, characteristics, and parts of the microscope and reviewing procedures for its use. In the fifth module, students become familiar with the levels of structure and complexity in the biological sciences (i.e., atom, molecule, organelle, cell, tissue, organ, organ system, and organism). The final module offers basic information on human anatomy, with particular focus on the human skeletal system. (EJV)

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Basic Science Training Program

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August 10, 1987

JC 880002

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WORKSHOP IN BASIC SCIENCE

STUDENT SKILLS

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ACKNOWLEDGEMENTS

I would like to tank Lake Michigan College, Benton Harbor, Michigan, for providing the interest and funds for staff professional development. Appreciation is also given to the Professional Development Fund Committee of Lake Michigan College for recommending this workshop proposal to the college.

I am also indebted to Faith Vruggink, biologist at Kellogg Community College, Battle Creek, Michigan, and fellow member of MCCB (Michigan Community College Biologists) for presenting this idea and materials at a workshop.

I would also like to thank the support staff for typing and duplicating these modules: (1) Study Skills, (2) Vocabulary, (3) The Metric System, (4) The Microscope, (5) Biological Science, and (6) Human Organ Systems. And, finally, to the participants, for whom it is desired that these workshop experiences may enhance their study skills, personal and professional lives, and a greater understanding and appreciation for the world of science.

Clete Brummel

Clete Brummel

Goal

Provide the students with skills necessary to study efficiently.

Objectives

Upon completion of the module and attending the workshop, the student should:

1. develop in writing a schedule that will analyze their time commitments.
2. plan in writing a schedule that includes class time commitments, work (job) commitments, family commitments, study time commitments, relaxation time.
3. develop the skills of good lecture note taking.
4. develop the skills of good textbook note taking.
5. develop methods of organizing information to be studied.
6. develop review skills for lab quizzes.
7. be less anxious about test taking.

Introduction

The purpose of this entire workshop is first to develop good study skills, and the second purpose is to review basic science. The review will give you the opportunity to practice and fine tune your study skills. Good study skills have several components; time management, lecture note taking, textbook note taking, a step-wise method of study, and in the case of science classes, lab skills.

Many students including some that are in medical schools and graduate schools do not know how to study. Many (most?) students think listening to lectures and reading the textbook 2 or 3 times is studying. Reading and listening are not studying! They are components of studying, but they are only the initial steps. Reading and listening are important. If you are unable to perform the first steps of a process, you cannot accomplish the remaining steps. Therefore, reading and listening are important but they are only the start of the study process. Reading and listening are passive activities. Good studying involves active components such as writing, speaking, and questioning.

Part I -- Time Management

Entering college and specifically entering a program of study in the health technologies necessitates a commitment of your time. The word commitment means in part a decision to use will power to discipline yourself to something or someone. It means that even when you don't "feel like it," you have promised yourself to do something. In college if you are to succeed, you must make a commitment of your time. The first time commitment you must make is to attend all classes and the second commitment is to study. An old rule of thumb is to study two hours per week for every hour in class. In anatomy there are five hours/week in class therefore, you should initially budget ten hours/week of study time outside of class for anatomy.

The most effective method of time management is to analyze your time by a written schedule or time analysis sheet. A time analysis sheet is useful to avoid feelings of being overwhelmed. To use this method of analysis (Fig. 1) cross off each hour that you are occupied with some activity; classes, job, cooking, eating, sleeping, driving to school, etc. From the resulting open times you can pick blocks of time to study. Pick times when you are most alert. If after your time analysis you do not have enough time to study, other activities must be reduced or eliminated. The place where you study is also important. Contrary to popular opinion, the T.V. and radio are not good study companions and neither is the cafeteria at school. (See also "Cookbook of Ideas for Managing Your Time," Fig. 1a). Effective studying requires concentration and no distractions.

When studying for a science class, do not try to study in huge blocks of time once every two weeks. i.e. cram. The golden rule of studying for a science class is to keep up! If you do not keep up you will be overwhelmed by all the facts and new information. If possible, study for your science classes the same day that you have lectures or before the next lecture. To do this it is a good idea to develop a fixed time schedule (Fig. 2). This schedule blocks out your time commitments by name, and you will be able to make time to study before your next lecture. If you study before the next lecture, you can then ask the instructor to explain anything that was unclear while it is still fresh in your mind, the instructor's, and other students.

Part II -- Overview of Study Method

Every instructor distributes a class syllabus on the first day of class. The syllabus is the schedule of topics that will be covered in lecture and lab; and it includes reading assignments. Therefore, the first step is to complete

TIME SCHEDULE

Figure 1

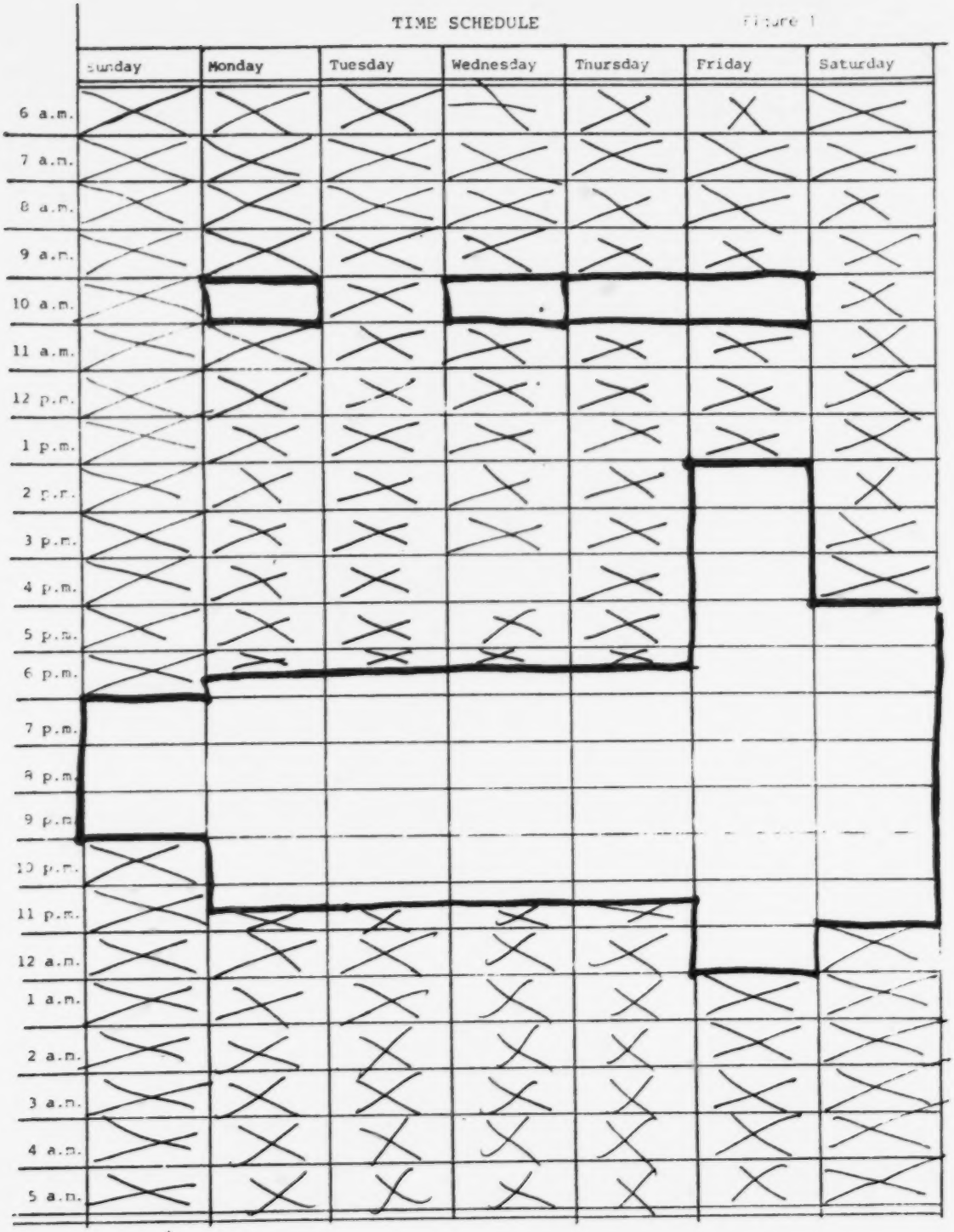


Figure 1a.

EAT A FROG FOR BREAKFAST AND LITTLE WILL GO WRONG FOR THE REST OF THE DAY

Below is a cookbook of ideas for managing your time. Pick out those that have the most meaning for you. While all of them are ideas that people have used to increase their available time, not all of them may be useful for you. Remember that if 20% of them can be used you can find yourself with more time for doing things you enjoy doing.

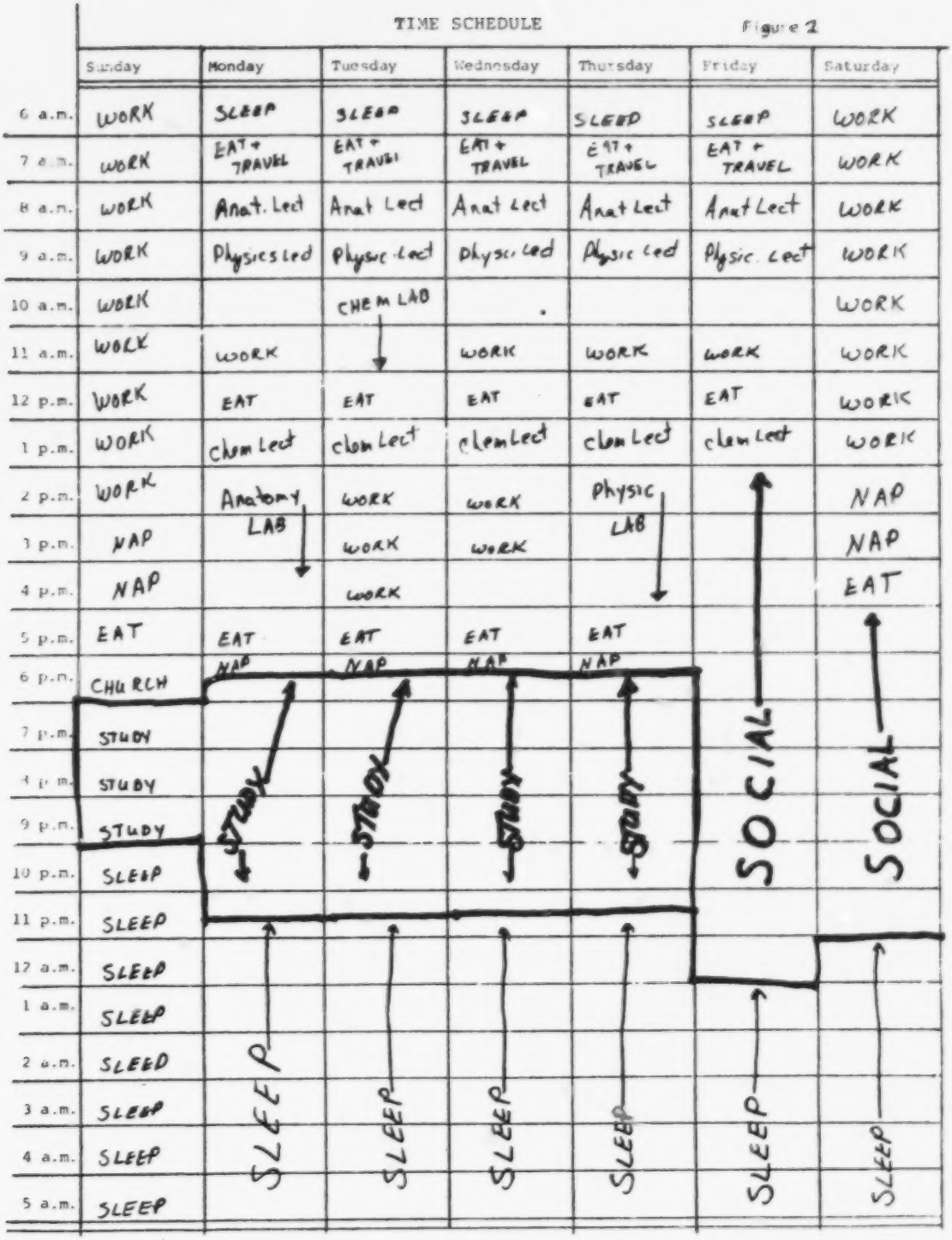
1. Be sure to have a desk calendar.
2. Write down all assignments with dates.
3. Carry 3 x 5 cards in your pocket.
4. Fill your time so that you can get results rather than just activities.
5. Use the 80-20 rule to your advantage.
6. Find out where you are losing time, then change.
7. Do it now.
8. Use a pencil in writing your daily activities calendar.
9. Have some planned unavailable time.
10. Learn how to listen.
11. Earn the right to relax.
12. Beware of perfection.
13. Keep the task in front of you as a reminder.
14. Don't be afraid to say no.
15. Don't always ask "What can I do with this time?" -- ask "What can I not do with this time?"
16. Work out some sort of interruption control.
17. What is your ultimate pleasure goal? Work goal?
18. Remember Parkinson's Law--work tends to expand to fill the time available.
19. Write out your short-range goals and long-range goals.
20. First things first.
21. Give yourself feedback.
22. Leave extra time. Remember Murphy's 3rd law--if anything can go wrong, it will.
23. Work at the best time.
24. Shower at night and decide your clothes the night before.
25. Learn to discipline yourself and feel good about it.
26. Plan to take 10 minutes off per study hour.
27. Schedule study time before recitation time and after lecture classes.
28. Concentrate on one thing at a time.
29. Start tough assignments immediately.
30. Don't doodle in class.
31. Try to do only A's; never B's and C's.
32. Check on TV time.
33. Value your time.
34. Organize your bathroom.
35. Wake up--get up.
36. Have a good study area (not bed).
37. Put ideas and tasks on mirror.
38. Remember, most of the students who are behind are the ones who were planning to just get by.
39. Try to enjoy whatever you are doing.

40. Plan in the morning and set priorities for that day.
41. Work smarter, not harder.
42. Have a light lunch so that you don't get sleepy in the afternoon.
43. Examine old habits and eliminate the poor ones.
44. Review your goals.
45. Give yourself time off and special rewards when you have done the important things.
46. Ask yourself would anything catastrophic happen if I did not get this done? If the answer is no, do something more important.
47. When you start procrastinating ask yourself, "What am I avoiding?" then confront this thing.
48. Your should have no "waiting time."
49. Always work at being an optimist.
50. Use the time that you use to wait to do other things.
51. Set deadlines for yourself.
52. Try not to waste other people's time because you are wasting your own.
53. When you can, delegate.
54. Don't waste time regretting failures.
55. Don't waste time feeling guilty about what you don't do.
56. Build on successes.
57. Remind yourself there is always time for the important things.
58. If it is important you can make time to do it.

This information is taken from a variety of sources, but two of the major ones are How to Get Control of Your Time and Your Life by Alan Lakein, Signet Books, New York, New York; and Putting it all Together by Laura Vinson, et al, Clemson, South Carolina.

TIME SCHEDULE

Figure 2



before class the reading assignments for a specific lecture unit or lab activity. The second step is to attend class. It is a good idea to arrive in the classroom early and find a seat in the front. This is especially true for lecture. It is easier to be attentive and listen in the the front than it is in the back of the room. The third step is to take accurate and detailed lecture notes. Note taking is an active process that involves your senses of hearing, sight and touch. Soon after class you should read through your notes to fill in any gaps while the lecture is fresh in your mind. This fourth step of quickly reviewing your notes should take on'y a few minutes.

During your scheduled block of study time for a specific class, you should revise and reorganize your lecture notes. Next, during that block of time, study the portion of textbook that corresponds to the lecture topics. After you have revised your lecture notes and studied your textbook, convert your objectives into questions and quiz yourself first with notes open then with your notes closed. If anything is unclear, make a note and ask the instructor and/or the tutor. Some people benefit from study groups which is a small group of students that question and quiz each other. When the time for a test approaches, if you have followed the suggested method, you will only need to review what you have already learned and you can relax during the hours before the test.

A. The Syllabus (see Sample A)

Anatomy syllabi are lecture and lab outlines and reading assignments for each unit.

B. Reading Assignments

Before the lectures begin, you should preview the chapter. To preview the chapter, read the introductory paragraphs and overview paragraphs, if any.

Sample A

BIOLOGY 205
HUMAN ANATOMY
Tentative Lecture & Lab Schedules
Fall, 1986-87

Week of	Topic	Text Chap Ref	Lab Ex
Sept. 1 (Labor Day) -Sept. 3 (Wed. - 6 p.m. - start classes)	Intro. Terms, Planes, Body Organization	1-3	I
Sept. 8	Cells, Tissues, Organs, Integument	4, 5, 7	II, III
Sept. 15	EXAM. Skeletal System	8	IV
Sept. 22	Articulations and Movements	9	IV
Sept. 29	EXAMS. Muscular System	10	V
Oct. 6	Muscular System	10	V
Oct. 13	EXAM. Digestive System	15	VI
Oct. 20	Respiratory System	14	VII
Oct. 27	EXAM. Circulatory System	13	VIII
Nov. 3	Circulatory System	13	VIII
Nov. 10	EXAMS. Nervous System	11	IX
Nov. 17	Nervous System, Senses	11, 12	IX, Start X
Nov. 24-26 (Wed. 3 p.m.)	EXAM. Senses		X & Supplement
Nov. 27, 29	THANKSGIVING		
Dec. 1	EXAM. Endocrine, Urinary	17, 16	XII, XI
Dec. 8	Urinary, Reproductive	16, 18, 19	XI, XII
Dec. 15	Reproduction Development. EXAM	19, 6	Review

These paragraphs will give you a general idea of the topics to be covered by the chapter. In the back of each chapter of your book is a "Study Outline" or "Summary." After you read the introductory paragraphs read through the Study Outline or Summary. Reading through the study outline will give a detailed overview of the entire chapter, alert you to significant points in the chapter and help to get the "whole" picture without getting lost in the details. Next, read the headings of the sections in the chapter, then look at the charts, photos or diagrams to see what information is provided through those media, and lastly, read the chapter or those portions that will be covered in the upcoming lecture. Pay particular attention to the bold face terms.

C. Lecture Note Taking (see Samples B and C and C_1)

All notes from one class should be in one notebook. DO NOT USE THE SAME NOTEBOOK FOR ALL YOUR CLASSES! Each set of notes should be dated and lecture notes must follow each other consecutively. The notes should be in modified outline form with major headings at the margin and subheadings indented. Major headings should also be underlined, etc. to make these headings "stand out." Note the two examples of lecture notes. Sample B and C both have the same information, but Sample C is far easier to read and understand. Also note that Sample C is dated and uses abbreviations. As you become familiar with note taking and a particular subject, you will find many words that are used repeatedly. In Sample C some examples of abbreviations are: sep. = separates, int. = interior, ext. = exterior, struc. = structure, func. = function, and o/ = other. The abbreviations that you use need only be understood by you, but using them increases your note taking efficiency. (See also C_1 for Abbreviations and Symbols).

Just reading your lecture notes is not a sufficient method of studying. Lecture notes should be revised and reorganized. Revising and reorganizing your

notes is a process that gets you actively involved with the subject. You may even end up talking out loud to yourself about the subject. This process requires you to think about the subject and understand the overall relationships of topics with the subject matter. One way to reorganizing is to devise a formal outline from your notes (Sample D). Leave lots of space so you can add information that you may gather from the text or other lectures. Revision also includes devising charts that demonstrate similarities and differences among related topics (Sample E). If a portion of the material requires you to memorize new words and terms, use flash cards (Sample F). Terms in anatomy will either be the name of a structure or the term will describe a process. If it is a structure, it also has a function, and you should know the function. If the term describes a process, it is an event that occurs under specified conditions and/or in a sequence of specific steps.

D. Textbook Note Taking (Handout)

Studying from a textbook involves note taking not just reading. If you have over viewed the chapter at the beginning of the unit, now is the time to read, underline, and note take from each section. Each section will have a heading and each paragraph one main idea or each paragraph will be an explanation using an example. As you read a section, underline new words, definitions, and main ideas, make notes in the margins, and study the illustrations. After you have studied the textbook, take notes from the text to supplement your formal lecture outline (Sample D).

E. Questioning

When you have completed note revision and have memorized new terminology, you should be able to ask yourself questions using the objectives from the instructor or start with the review questions at the end of the chapter. Write your questions out and then answer them verbally and in writing. The questions

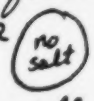
(cont'd on page 18)

SAMPLE C_1

Some Commonly Recognized Abbreviations and Symbols

w/	=with
w/in	=within
w/o	=without
vs	=against
..	=therefore
re:	=concerning
=	=equals, is the same as
≠	=does not equal, is not the same as
	=equals approximately
---	=leads to, causes, produces, results in
c.	=approximate (uses w/dates, e.g., c. 1919)
e.g.	=for example
i.e.	=that is
/	=per (e.g. 79¢/lb)
f.,ff.	=following page, pages
def.	=definition
arg.	=argument
c.f.	=compare, refer to
ctr.	=contrast
esp.	=especially
>	=greater than
<	=less than
E	=is an element of
	=increases

cell membrane separates interior of cell from exterior made of protein and lipid
semipermeable regulates passage of substances into and out of cell. Passive transport. diffusion
allow some movement of molecules from region of high concentration to region of low concentration
substance until equilibrium is reached. Small ions and molecules enter cell by diffusion
to pass in example

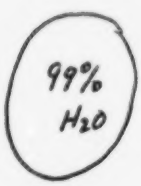


but not other Salt Salt will move by diffusion into cell.

facilitated diffusion also movement of molecule from high concentration to low concentration but requires a carrier molec (a protein) to help the cell membrane. ex glucose enters cell by ~~stg~~ facilitated diffusion. Osmosis movement of water from region of high water concentration to region of low water concentration thru a semipermeable membrane. example

100% H_2O water will enter cell.

example



90% H_2O water will leave cell.

Active transport requires energy and carrier molecule substance is transported from region of low concentration to region of high concentration.
energy is in form of ATP energy molecule.
Phagocytosis cell eating. Cell taking large particle from outside to inside by surrounding particle with membrane Pinocytosis cell drinking. similar to phagocytosis only liquid.

POOR LECTURE NOTES
NO HEADINGS
NO OUTLINE
NO DATES

9/12 **Cell Membrane**

sep int of cell fr. ext.

struc.

protein + lipid

Func.

reg. mov. of mat. in + out.

Semiperm - allow passage of some sub. not o/s.

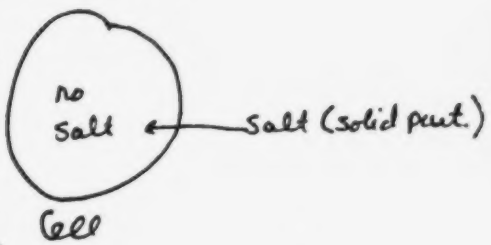
Mech of Mov thru Memb.

- Passive process no energy req.

1. Diffussion

mov of molec from hi conc. → low conc. until equal bet. reached.

ex

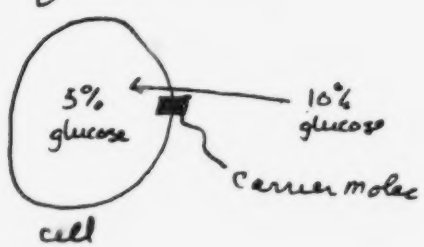


2. Facilitated diffussion

high → low

req. carrier molec.

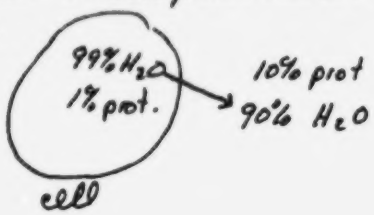
ex

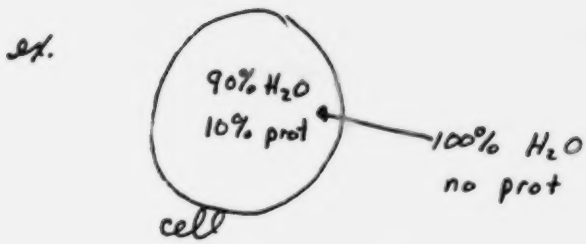


3. Oomosis

mov of H_2O from high H_2O conc → low H_2O conc thru a semiperm memb.

ex.





- Activ Process. req. cell to used stord E
  1. activ transpat
     move low → high
     carrier molec.
     energy (ATP cell's energy molec.)

9/14

2 Phagocytosis. "cell eating.
  lg solid particle
  mov ~~and~~ ext → int.
  cell memb. engulfs particle.

3 Pinocytosis "cell drinking"
  sim. to phagocytosis.
  liquid instead of solid.

Sample D

I. Cell Memb

A. Struc.

1. protein - embeded in Lipids
2. lipid - bilayer
3. pores

B. Func.

FACTORS WHICH DET PERM
1. SIZE
2. Solubility in Lipids
3. charge
4. carrier molec.

1. sep. cell
2. reg. move. of mat. in & out
3. semiperm - allow passage of some sub, not others synonms differentially selectively
4. Receptor site.

C. Mechanisms of Move. thru. memb.

1. passive process
   a. no energy — Conc. gradient = dif. betwn high & low conc
   b. high ⟶ low cone.
   c. equalibrium - move. in both direction; even distribution
   d. types
      1) diffussion
         a) ions & small molecules
         **b) no carrier molecule
      2) facilitated diffusion ⟶ RATE LIMITED BY
         1. conc. grad.
         2. amt. of carrier
         3. how quickly carriers sub combine
         a) glucose example.
         **b) carrier molecule
      3) osmosis
         a) water
         b) thru semiperm memb.
2. active process
   a. req. stored energy of cell
   b. types
      1) active trans. energy source ATP
         a) low ⟶ high
         b) carrier
         c) small molecules
      2) phagocytosis "cell eating"
         ex. white blood cells.
         a) lg solid particle
         b) ext ⟶ int.
         c) memb engulfs
      3) pinocytosis — "cell drinking" ex. cells of Kidney
         a) sim. to phagoeytosis
         b) liquid droplet

Sample E

NAME	TYPE	DIRECTION	CARRIER	ENERGY	SUBSTANCE	SIZE
Diffusion	Passive	hi → low			solute	small
Facilitated Dif.	Passive	hi → low	X		solute	small
Osmosis	Passive	hi → low			solvent H_2O	small
Activite trans.	Active	low → hi	X	X	solute	small
Phagocytosis	Active			X	particle	lg.
Pinocytosis	Active			X	liquid	lg.

Sample F

FRONT	BACK
Osmosis	process. move. of H_2O thru semiperm memb. high → low H_2O cone.

FRONT	BACK
Cell Membrane	structure protein & lipid func. reg. move. of subs into cell

you devise should be of two general types. One type is recall questions such as "What is the cell membrane composed of?" "What is the definition of diffusion" The other type is a cause and effect question such as "What effect would lack of stored energy have on active transport?" "What would happen if a cell were placed in pure water?" Questions on anatomy tests will be both recall and synthesis (cause and effect). For the questioning part of studying many students find it valuable to form study groups. A study group is very beneficial if everyone has done their "homework," and everyone actively participates in the question asking and answering. Passively listening is not helpful. The entire method and process of studying involves as many of your senses as possible.

Part III -- Lab

A. At the beginning of the semester, you will receive a lab schedule that will have listed all of the lab assignments for the entire semester. You should read through each lab assignment before you come to lab. Labs are like cooking. It's easier if you read through the recipe completely and know what you are going to do, than if you don't read it thoroughly. Many labs will be performed as a group. It will save time if your group takes a few minutes at the beginning to organize and communicate who is doing what part of the lab. A few assignments will require more than the 2 hours allotted lab time. In those situations, it is up to you to complete the lab on your own time before the next lab period. During each lab period there may be a quiz over the previous lab. To study for a lab quiz, review the procedure and any drawings, diagrams, specimens, or models that accompany the lab. The quizzes are very short and usually take the first 15 minutes of the lab period.

B. **Laboratory Tests**

As one aspect of evaluation of work done in the laboratory, your instructor may give laboratory tests. The frequency of such tests will be announced by the instructor. The following methods are often employed in testing in the laboratory.

1. Practical

This type of test may include actual specimens (e.g., bones), microscope slides, drawings, and questions. There are several ways in which such a test may be given. One method commonly used involves the establishment of from 30 to 40 test stations. One or more specimens, a microscope with a slide in focus, a diagram or drawing with structures to be identified, or a card containing written questions is located at each station. The student is provided with an answer sheet and stands at a specified station. At the signal to begin, the student answers the questions (usually from three to five) asked at that station. The time allotted for this task varies from 45 seconds to 1 1/2 minutes. When time is called, the student moves to the next station, and so forth, until the test is completed.

2. Orals

In this type of test, the student is asked to bring a specimen he has dissected to the instructor, who then asks the student to identify selected structures. The student may also be asked to give functions of the structures identified. In some cases, models may be used for giving oral tests.

3. Written Tests

These may take a variety of forms (short answer, identification, essay, etc.). These tests are designed to determine the student's understanding of the work performed in the laboratory.

During the rest of the workshop, use this method of studying.

Final Exams

HOW TO IMPROVE TEST SCORES: TIPS

1. GO TO CLASS
2. Take Notes
3. Study REGULARLY

Test Taking Strategies:

1. Anticipate test information:
   - A. Analyze th Instructor.
   - B. Check old exams and worksheets.
   - C. Compare old tests and lecture notes for duplication.

2. Review:
   - A. Re-read underlined parts of text.
   - B. Write summaries of text, lecture notes.
   - C. Self-test.

3. Physical Preparation:
   - A. Get a good night's sleep.
   - B. Eat breakfast.
   - C. Avoid coffee or caffeine.

4. Pre-test:
   - A. Read directions slowly AND carefully, and follow them.
   - B. Write out needed formulas.
   - C. Bring all necessary materials.
   - D. Answer easy questions first.
   - E. Re-write confusing questions in your own words.
   - F. Work steadily and quickly.
   - G. Check your work when finished.
   - H. Ignore other students around you.

6. Post-test:
   - A. Review the returned exam for what went right/wrong.
   - B. Discuss what went wrong with the instructor.

TYPES OF TESTS

OBJECTIVE

True-False, Matching, Completion, Multiple Choice

TRUE-FALSE

1. Specific determiners for TRUE.
2. Specific determiners for FALSE.
3. If a statement is partially false, it is all false.
4. Watch out for double negatives.
5. If a question sounds strange, it is probably false.
6. If time is out, determine a pattern from previous questions and answer those that remain either all TRUE or all FALSE based on the pattern.

MATCHING

1. Use a process of elimination.
2. Association--use information within other questions (from review of test) as clues.
3. Grammatical agreement.

COMPLETION

1. Always write in something.
2. Clues in number of lines in question.
3. Clues in length of line(s) in question.
4. Grammatical agreement.

MULTIPLE CHOICE

1. Among the choices, look for opposites. One is likely the correct answer.
2. Among the choices, look for redundant answers. Both are likely to be wrong.
3. Use inter-item clues.
4. Look for parts in answers that you know are correct.
5. General questions usually have general answers.
6. Items mentioned more than once can be clues to a correct answer.
7. Choose middle value alternatives.
8. Choose the longest/shortest alternative, based upon the instructor's style.
9. Use association.

STUDY

ESSAY

1. Make a brief outline of your answers to all the questions before you write any answers.
   Why:
   A. Forces organization
   B. Gets mind working in right direction
   C. Puts subconscious to work
   How:
   A. List all the points that occur to you, main ideas, important details
   B. Number the main ideas in logical order
   C. Number the letter important details

2. Opening sentence should be direct and to the point--use important key words from the question in the answer.

3. Support your answer point by point, and use transition words to guide the instructor through your answer.
   A. Series--first, second, third
   B. More of the same--in addition, additionally, also, and
      Contrast--but, however, in contrast, on the other hand
      Examples--for example, for instance

4. When you don't know the answer, write down as much as you do know. DO NOT offer excuses or pad the material.

5. When running out of time, jot down the main points of your answer in outline form.

6. Neatness--appearance counts.
   A. Legible handwriting
   B. Room in margins and between answers--for corrections, additions
   C. Are outlines or calculations out of the way

The Vocabulary of Test-Taking

In exams, the most common mistake is to misunderstand the question. For example, in an essay exam, if you're supposed to "list the causes," sometimes students will "compare the causes" or "discuss the causes." If the professor asks for a list, then give him/her a list--nothing else. You must learn the meanings of common test words.

General Category	Examples of Specific Terms	Answer Needed
Identification	cite, define, enumerate, give, identify, indicate, list, mention, name, state	present the bare facts: a name, a phrase, a date; in short, provide a concise answer.
Description	describe, discuss, review, summarize, diagram, illustrate, sketch, develop, outline, trace	tell about a specific topic with a certain amount of detail.
Relation	analyze, compare, contrast, differentiate, distinguish, relate	describe the similarities, differences or associations between two or more subjects.
Demonstration	demonstrate, explain why, justify, prove, show, support	show (not state) why something is true or false. Put forth logical evidence or arguments to support a specific statement.
Evaluation	assess, comment, criticize, evaluate, interpret, propose	give your opinion or judgment on a subject plus justify and support it. Also, if your opinion can be challenged be sure to present both sides.

Sample Test Questions:

1. Compare and contrast the practices and philosophies of the A.F. of L. and C.I.O. in the period immediately following the creation of the C.I.O.

2. Diagram a life script matrix, showing the relevant components according to Claude Steiner.

3. Discuss the problem of food production and the world population explosion.

4. Illustrate the theory of the grasshopper self-concept.

5. Criticize the theory of cultural relativity.

VOCABULARY FOR ESSAY EXAMINATIONS

When the examination states:	You must show on the paper:
1. compare	Two or more items showing similarities and differences.
2. contrast	Two or more items showing differences or dissimilarities.
3. diagram	A picture, chart, or plan.
4. enumerate	A numbered list of items or ideas- 1, 2, 3, 4, 5,.
5. evaluate	A reasoned judgment; authoritative reasons.
6. explain	How and why.
7. criticize	Your point of view, and the arguments that support or reject it.
8. illustrate	An example, or examples.
9. interpret	An explanation of why.
10. justify	Proof of why this is.
11. outline form	Main points and essential details.
12. summarize	Several core ideas.
13. trace	A sequence - start with a date and go forward or backward, or give in the order of happening.

Use good review techniques

Preparing for exams should really be a matter of review. The time involved should be no more than 15 minutes for weekly quizzes, 2 to 3 hours for a mid-term exam, and 5 to 8 hours for a final exam.

Plan your review systematically and consistently. Look at your course outline, your lecture notes and your text notes. What are the major topics in each? Make a listing of them. Recall the special emphasis placed on certain topics in class and on chapter headings. These are all major points that are particularly important and well worth reviewing closely.

Summarize your text and class notes. Use this summary to remind yourself of all the information you have amassed on a particular topic.

Ask your teacher for an explanation of the scope of the exam. What are her or his goals for the exam? How will you be evaluated – by your knowledge of facts and details or by your understanding of ideas and concepts?

Review with others as long as it doesn't take the place of your own review. You'll have the advantage of sharing information with others who are reviewing the same material.

Cram, only if you must, but be selective. Skim each textbook chapter and each lecture for main ideas and list them on a summary sheet. Then recite, recite, and wish for the best.

Organize your pre-exam hours

Finish your exam preparation the evening before the exam by reviewing your summary sheets and fitting that information into a total and meaningful picture.

Have a good night's rest. If taking the exam in the evening, try to rest your mind and body for a few hours beforehand.

Don't rush. Allow yourself plenty of time to dress, arrive at the exam room, and get settled. Rushing will only add unnecessary pressure.

Eat a sensible meal rather than "junk food."

Stay calm. Some anxiety is natural and helpful. It sharpens your senses and "gets the adrenalin" going. But too much worrying just gets in the way. Think of the exam as only one part of the entire learning process.

Arrive early at the exam room so you can find a good seat with plenty of light. Sit away from friends and distractions. Get comfortable.

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Plan out your approach to the exam

Read and understand the directions thoroughly. Do you have to answer all the questions or may you choose which ones to answer? Is there a time limit for each question? Will some questions count more than others in grading?

Read all the questions before answering any of them. This strategy will prevent you from putting down information for an early question that more appropriately belongs in your answer to a later question. Again, it will tell you if you have a choice between questions and whether some of them will count for more than others.

Jot down key words and phrases from your memory right on the exam questions. These reminders will help you organize your answers as you begin your written responses.

Calculate your time. Decide how much time you should devote to each question and how much time you'll need for review. Stick to your plan.

Start with the easiest question. This will give you confidence that you can handle the questions and will get you off to a flying start.

Be neat and legible. Write on one side of the paper only, leaving a wide (1½ inches) margin on the left hand side of the paper for your instructor's comments. Reserve space between answers so you have room for expansion should additional thoughts occur to you.

Keep the left hand page in your blue book blank. You can then make additions and/or changes in your answers on this blank page, drawing an arrow from these additions to the place on the right hand page where you wish the added material to go.

Objective tests come in various forms: true-false, multiple choice, completion or fill in the blank, and matching like items. These tests show your knowledge of facts and details. You must read the instructions carefully to find out: must you answer all the questions? Will blanks count against you? Pay close attention to key words – *all, none, never.* When you're unsure which answer in a multiple choice question is the best, make a check next to the answer you initially feel is right and come back to it later for a final decision. Be sure to erase your earlier marks should you change an answer. You should have only one answer for each question. (See Figure 1 for examples of various objective questions.)

Essay questions go beyond objective tests: they require you to recall facts and ideas but further demand that you organize the information into thoughtful sentences and paragraphs. Be sure you understand the question as it is phrased and that you are aware of all the *parts* of the question before you begin your response. Underline or circle the key words in the question – *analyze, contrast, explain, interpret, summarize,* etc. Make your opening statement a summary of what you are going to say. Be direct and forceful. If you feel that you are running out of time and won't be able to finish some questions, write an outline for them. This will show your instructor that you did know the material but ran out of time. Make your answers as concise and clear as possible. Avoid repetition. Review all your answers after completing all the questions. Check to be sure you haven't omitted a key word or point.

Make each exam a learning experience

Review your corrected exam papers. Study your strengths and weaknesses. Note the comments made by your instructor and ask him/her for further explanation if they aren't clear to you. Each exam taken should help you do better on the next one.

Reassess your grades and work

When you receive your grades and get back exam books, read over the answers. Compare them to your textbook and class notes in order to check mistakes and find out why or how you answered incorrectly. If you don't understand your instructor's marks, ask him where you went wrong. This re-evaluation will help you recognize faults in your study skills. Learn by your mistakes and go on to the next phase of enjoyable and successful college work.

Figure 1*

Different types of true-false questions

Although the most common form for alternate-response items is that of a direct statement which is to be judged true or false, there are several variations, among which are the following:

1. The pressure in a fixed quantity of a gas varies directly as its volume if the temperature remains constant. T F
2. Does a ripsaw have larger teeth than a crosscut saw? Yes No
3. *Make every false statement true by suggesting a substitute for the underlined word.*
   The use of steam revolutionized transportation in the seventeenth century. _____
4. The volume of a mass of gas
   a. tends to increase as the temperature increases; T F
   b. tends to increase as the pressure increases; T F
   c. may be held constant by increasing pressure and decreasing temperature; T F
   d. may be reduced by increasing pressure and decreasing temperature. T F

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A sample multiple-choice question

The examples that follow illustrate items that measure the various levels of the cognitive domain.

The following item measures knowledge or rote learning:

In the normal curve, what percent of the cases lies within one standard deviation plus and minus the mean?

a. 62 percent
b. 68 percent
c. 75 percent
d. 58 percent
e. 34 percent

Two types of short-answer (completion) questions

1. *Question:*
   What is the technical name for nearsightedness?
   (_____)

2. *Incomplete sentence:*
   The name of the first man to sail around the world was (_____)
   (_____)

A typical matching-like-items question

Each city on the left is the capital of one of the countries on the right. Place the letter of the country on the line before its capital city.

_____ Canberra	a. Australia
_____ Edinburgh	b. Canada
_____ London	c. England
_____ Ottawa	d. Irish Free State
	e. Scotland

*All examples cited from John A. Green, *Teacher-Made Tests*, 2nd ed., Harper & Row, 1975.

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This is a one (1) credit-hour course entitled Power Study Skills 090 offered in the Fall semester through the Reading Lab. The course covers note taking, exam taking, book reading, marking and comprehension, vocabulary building, applying study skills to essay/projects, etc.

Pauk, Walter, How to Study in College, Jamestown Publishers, 1984.

This text is used in a three (3) credit-hour course entitled Study Skills 095 to be offered for the first time in the Fall 1987 through the Reading Lab. Objectives for this course include goal setting, listening skills, taking better class notes, exam preparation, and vocabulary and reading development.

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WORKSHOP IN BASIC SCIENCE

VOCABULARY

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VOCABULARY

Your ability to communicate and to comprehend and to reason and to interpret depends upon the acquisition of a functional vocabulary. This is especially true of any science course, wherein the vocabulary practically constitutes a "foreign language." It is therefore important for you to develop an understanding of all unfamiliar words with which you come in contract in the process of your reading and investigations. Define all new words in terms **you** understand. Practice pronouncing the words. Make a conscious effort to use the new words until, by constant reinforcement, they are firmly entrenched in your mind.

Goal

The student will be able to derive the meaning of new words that contain root words, prefixes and/or suffixes which they have previously learned.

Objectives

Upon completion of this module and attending lecture the student should be able to master the following with 70% mastery.

1. Memorize the root words, prefixes, and suffixes on each list. (one list per day)
2. Complete the matching section of written quiz that corresponds to each list.
3. Complete the definition section of a written quiz that corresponds to words that contain root words, prefixes, and/or suffixes from each previous list.

Introduction

In any discipline there is specific terminology that is used by the specialists in that discipline. Human anatomy is a field that studies the structure of the human body, and there is specialized terminology that describes very specifically these structures and their parts. Part of anatomy then will be memorizing the names and terminology which describe various body parts and processes. This memorizing process can be simplified by learning the meaning of several root words, prefixes and suffixes. These are then combined and arranged to form hundreds of very specific words. For example, the suffix -ology means "study of." The root bio means life. Biology is the study of life. The root hist means "tissue." Histology is the study of tissues; -patho means disease. Pathology is the study of changes brought on by disease. Histopathology is the study of the disease process of tissues. Therefore, by learning several prefixes and suffixes the meaning of a new word can be derived.

This module contains lists and definitions of several root words, prefixes and suffixes. Each day you will be responsible for learning a new list. At the end of the workshop, there will be a cumulative test over the vocabulary.

VOCABULARY

1. a-, an- = absence or want
   ex. anaerobic = without oxygen
2. bio- = life
3. -logy = the study of
4. kilo- = one thousand; 1,000
5. deci- = one tenth; 1/10
6. centi- = one hundreth; 1/100
7. milli- = one thousandth; 1/1000
8. micro- = 1. one millionth; 1/1,000,000
   2. small
9. mega- = 1. one million; 1,000,000
   2. large
10. macro- = large
11. cyto- = cell
12. ant-, anti- = opposed to; preventing or inhibiting
    ex. anticoagulant = substance which prevents blood clotting
13. arth-, artho- = joint
14. cardi-, cardio- = heart
15. -pathy = disease
16. hist- = tissue

EXERCISE -- Make up a set of flash cards to assist you in memorizing the above list.

VOCABULARY

1. ab- = departing from; away from
   ex. abduct = move a limb away from midline

2. extra = outside, beyond
   ex. extracellular = outside the cell

3. exo-, ecto- = out, outside, away from
   ex. ectopic pregnancy = outside of uterus

4. endo-, en- = inner, within
   ex. endocardium = inner layer of heart

5. hypo- = below, deficient
   ex. hypoglycemia = low blood sugar

6. hyper- = excess
   ex. hypertension = high blood pressure

7. iso- = equal
   ex. isometric = equal length

8. inter- = between
   ex. intercellular = between cells

9. intra- = inside
   ex. intracellular = inside cells

10. epi- = over, above
    ex. epidermis = outer layer of skin

11. peri- = around

12. meso- = middle

13. -is, -sis = condition, state

14. -itis = inflammation
    ex. arthritis = inflammation of joints

15. -scope = instrument used to examine or look into

EXERCISE -- Make up a set of flash cards to assist you in memorizing the above list.

VOCABULARY

1. ad- = to or toward
   ex. adduction = move limb toward midline
2. angi- = vessel (as in blood vessel)
3. aut-, auto- = self
4. broncho = trachea (air passage)
5. cephal- = head
6. cerebro- = brain
7. crani = skull
8. entero- = intestine
9. gastro- = stomach
10. morpho- = form
11. myo- = muscle
12. osteo- = bone
13. sym-, syn- = together
14. -ac = referring to
    ex. cardiac = referring to the heart
15. -gram = data that is systematically recorded
16. -graph = instrument used for recording data

EXERCISE -- Make up a set of flash cards to assist you in memorizing the above list.

VOCABULARY

1. carcin- = cancer
2. -gen = an agent that initiates
   ex. carcinogen = cancer causing agent
3. chondr- = cartilage
4. costa = rib
5. hema-, hemato-, hemo- = blood
6. -poiesis = formation
   ex. hematopoiesis = formation of blood
7. hepat- = liver
8. homeo-, homo- = same
9. leuko- = white
10. lip- lipo- = fat
11. myelo- = spinal cord, or marrow
    ex. osteomyelitis = inflammation of bone marrow
12. nephro- = kidney
13. neuro- = nerve
14. poly- = many
15. retro- = behind, backward
16. sclero- = hard
    ex. arteriosclerosis = condition; hardening of the arteries

EXERCISE -- Make up a set of flash cards to assist you in memorizing the above list.

VOCABULARY

1. aden-, adeno- = gland
2. amphi- = on both sides; in two ways
3. bi-, bin- = two
4. di- = twice, double
5. glosso- = tongue
6. hemi- = half
7. hydra-, hydro- = water
8. mal- = bad, faulty
9. meningo- = membrane
10. metro- = uterus
11. stasis- = stand still
12. viscero- = organ
13. -lyso, -lysis = loosening, to break down
    ex. hemolysis = rupture of blood cells
14. -emia = condition of the blood
15. erythro- = red
16. glyco- = sugar

EXERCISE -- Make up a set of flash cards to assist you in memorizing the above list.

VOCABULARY

The following are directional terms

1. prone = horizontal, face down
2. supine = horizontal, face upward
3. anatomical position = body erect, feet together, upper limbs hang at the side, fingers extended, palms of hands forward, thumbs pointing away from body
4. anterior (ventral) = front
5. posterior (dorsal) = back
6. superion (cranial) = towards head or above
7. interior (caudal) = away from head or below
8. medial = toward midline
9. lateral = away from midline
10. proximal = toward the attached end of a limb, origin of a structure or the midline
11. distal = away from the attached end of a limb, origin of a structure or the midline
12. superficial (external) = located close to or on the body surface
13. deep (internal) = located further beneath the body surface than superficial structures
14. sagittal plane = longitudinal section that divides body in right and left parts
15. frontal (caronal) plane = longitudinal section that divides body into anterior (front) and posterior (back) parts
16. transverse plane (cross section) = divides body into superior and inferior parts

EXERCISE -- Make up set of flash cards to assist you in memorizing the above list.

VOCABULARY

The following are regional terms

1. cervical = neck
2. thoracic = chest (thorax)
3. lumbar = portion of between thorax and the pelvis
4. sacral = lower portion of back, superior to buttocks
5. plantar = sole of foot
6. palmar = anterior (surface of hand [palm])
7. axial = (armpit) attachment of upper limb to body trunk
8. ingiunal = (groin) junction of thigh with abdominal wall
9. abdomen = frontal region between thorax and pelvis

The following are internal body cavities

10. dorsal (posterior) cavity = 2 sub-divisions
11. cranial cavity = sub-divisions of dorsal cavity, contains brain
12. spinal (vertebral) cavity = sub-divison of dorsal cavity, contains spinal cord
13. ventral (anterior) cavity = 2 sub-divisions separated by the diaphragm
14. thoracic cavity = sub-division of ventral cavity, contains respiratory organs and heart
15. abdominopelvic (peritoneal) cavity = sub-division of ventral cavity, contains G.I. tract, urinary system, reproductive system
16. pleural cavity = sub-division of thoracic cavity, contains the lungs
17. pericardial cavity = sub-division of thoracic cavity, contains the heart

EXERCISE -- Make up a set of flash cards to assist you in memorizing the above list.

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WORKSHOP IN BASIC SCIENCE

THE METRIC SYSTEM

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Goal

The student will be less apprehensive about the metric system and will be able to perform quantitative measurements and estimates using the metric system.

Objectives

Upon completion of this module and attending lecture the student should be able to perform the following with 70% mastery.

1. List the basic metric units of length, volume, mass, and temperature.
2. List the abbreviations for the metric units of measurement.
3. List and define the prefixes employed in the metric system.
4. Convert one unit of metric length into other units of metric system
5. Convert one unit of metric volume into other units of metric volume.
6. Convert one unit of metric mass into other units of metric mass.
7. Using a meter stick or metric ruler measure the length and/or height of various objects.
8. Using graduate cylinders measure the volume of various substances and containers.
9. Using a balance measure the mass of various objects and substances.
10. Write in grams the metric equivalent to pounds and the English equivalent in pounds to the kilogram.
11. Write the metric equivalent to the following temperatures; boiling point of water, human body temperature, room temperature, and freezing point of water.
12. Estimate in metric units the length, width or height of objects and/or persons.
13. Estimate in metric units the volume of substances and containers.
14. Estimate in metric units the mass of objects and/or persons.
15. Estimate temperatures in metric units.

Instructions

This module is divided into sections. Each section covers one concept or topic that is a component of the metric system and has several exercises that enable you to test yourself over the material in each section. Work through each exercise and check your answer with those provided on the yellow sheets. After you complete the entire module, take the self-test. The answers to it will be provided in class the following day. Also, in class the following day, there will be a lab period with several "hands-om" activities that will enable you to perform measurements and estimates using the metric system.

Introduction

The metric system is the system of measurement used by all scientists and countries except the United States, and the metric system is a base ten system. The apprehension that the metric system conjures up is due to its being new and unfamiliar. Many of the tasks we now perform routinely were, when we first learned them, difficult. Activities like telling time, counting money, riding a bicycle, driving a car, cooking, and tuning engines were at one time baffling and confusing to all of us. Yet many of the tasks on that list we now consider easy. They are easy today because when we first learned them we started at the beginning with simple activities relating to those tasks. Once we learned them, we used them repeatedly. So in learning the metric system we are going to start at the beginning and repeat many activities.

Part I -- Review of Numbers and the Monetary System

Before we start with the metric system, we should review our number system and our monetary system which are very similar to the metric system. The number system we use is a base ten system as is our monetary system. That means in any number we write, there is a ones place, a tens place, etc. to the left of the decimal and a tenth place, a hundredths place, etc. to the right of th decimal. The numbers to the left of the decimal are termed whole numbers an those to the right o. the decimal fractions. Every number we write has a decimal whether we designated it or not. For example, the number "1" has an understood decimal immediately to the right of it, and we could and in science should write it like this "1.0". Writing it in the last form means that it represents one and no fractions.

In our number system, fraction or portions of whole numbers can be expressed in two forms, a decimal form and a fractional form. The fractional

form consists of a numerator (top number) and a denominator (bottom number). To convert a fractional form to a decimal form, the numerator is divided by the denominator. Thus the fractional forms 1/2, 2/5, and 3/10 become 0.5, 0.4, and 0.3 respectively. If the denominator is 10, 100, etc. the division and therefore conversion is greatly simplified. When we divide by 10, we simply move the decimal one place to the left. Conversely, if we multiply by 10 we move the decimal one place to the right. In general, when we divide the decimal is moved to the left, and when you multiply the decimal is moved to the right.

EXERCISE A

Complete the following:

776.0 x 100 = _____

24.13 x 1000 = _____

7.1 - 10 = _____

12.6 - 1000 = _____

Fractional Form	Decimal Form
3/6	= _____
5/8	= _____
1/10	= _____
35/100	= _____
57/1000	= _____

Next by way of review, let's briefly examine our monetary system which like our number system and the metric system is based on units of ten. The basic unit of our money system is the dollar ($). Dimes and pennies (¢) are fractions of a dollar and ten dollar bills and hundred dollar bills are multiples of a dollar. Thus, when we observe a price tag marked "$11.10", we know that means

1-ten dollar bill, 1-one dollar bill and 1 dime or 10 pennies. We are able to convert $11.10 into dimes or pennies because we first know the relationship between dollars and dimes or dollars and pennies. Those relationships are 1 dollar = 10 dimes and 1 dollar = 100 pennies. In fractional terms 1 dime = 1/10 of a dollar and 1 penny or cent = 1/100 of a dollar. Secondly to convert $11.10 into dimes or pennies we perform the mathematical procedure of multiplication. Without the aid of a calculator we solve the following expression to determine the number of dimes in $11.10.

$$\frac{\$11.10}{1} \times \frac{10 \text{ dimes}}{\$1}$$

In words this means $11.10 multiplied by 10 dimes per 1 dollar.

In this expression the unit "dollar" ($) cancels out and we are left with the following:

$$11.10 \times 10 \text{ dimes} = 111.0 \text{ dimes}$$

EXERCISE B

Set up and solve the mathematical expression used to convert $11.10 into the correct number of pennies.

In the two previous examples we converted a large unit, dollars, into smaller units, dimes or pennies. We also can automatically convert small units (pennies) into larger units, dimes or dollars. If we take 300 pennies to the bank we could exchange those 300 pennies for either 30 dimes or 3 ones. We and the teller both performed a two step mathematical process to determine the equivalent number of dimes or dollars.

Step 1 Relationship between pennies and dimes

1 penny = 1/10 dime or 10 pennies = 1 dime

Step 2 Mathematical expression

$$\frac{300¢}{1} \times \frac{1 \text{ dime}}{10¢}$$

In words, this reads: 300 pennies multiplied by one dime per 10 pennies.

The unit penny (¢) cancels out and we are left with the following:

$$\frac{300}{1} \times \frac{1 \text{ dime}}{10}$$

$$\frac{300 \text{ pennies}}{10} = 30 \text{ dimes}$$

EXERCISE C

Try to convert 300 pennies into dollars.

Step 1

Step 2

EXERCISE D

Convert 120 singles into the correct number of ten dollar bills:

Step 1

Step 2

If you correctly perform conversions in our monetary system, you can use the metric system.

Part II -- The Metric System

The metric system is just like our monetary system. The basic units are the meter (m) for length, the cubic meter (m^3) for volume, and the gram (g) for mass ("weight"). Within each type of measurement there are units that describe a fraction of the basic unit or a multiple of the basic unit. The prefixes which indicate fractions of the basic unit are: deci (d) which means 1/10, centi (c) which means 1/100, milli (m) which means 1/1,000, and micro (u) which means 1/1,000,000. Thus, a centimeter is 1/100 of a meter or 0.01 m. The prefixes which describe the basic unit multiplied by some factor are: deka (dk) which means ten, kilo (k) which means one thousand and mega which means one million. Thus, a kilometer is 1000 meters.

EXERCISE E

Complete the following chart:

multiple or fraction		prefix
1,000,000	=	_____
1,000	=	_____
0.100	=	_____
0.010	=	_____
0.001	=	_____
0.000001	=	_____

A. Length

The meter is measure using a meter stick which is approximately 39 inches long. We use the meter to measure short distances such as 100 m dash, the length of a room or an individual's height. Longer distances are measured using the units of kilometers (km). A kilometer is approximately 0.62 miles. Smaller lengths are measured using decimeters (dm), centimeters (cm), millimeters (mm) and sometimes micrometers (um). The following chart indicates the relationships that exist with the metric units of length.

1,000 m = 1 km

1 m = 1 m

0.1 m = 1 dm

0.01 m = 1 cm

0.001 m = 1 mm

0.000001 m = 1 um

EXERCISE F

Complete the following chart:

1 km = _____ m

1 m = _____ dm

1 m = _____ cm

1 m = _____ mm

1 m = _____ um

The preceding charts provides us with the relationship necessary to convert one unit of metric length into other units. The procedure is the same used to convert units in our money system. Step 1 is to determine the relationship between the two units of measurement, and step 2 is to set up the appropriate mathematical expression; and then multiply or divide by the correct factor.

For example, if someone ran 0.750 km, how many meters did they run?

Step 1 Relationship between meter and kilometer

$$1{,}000 \text{ m} = 1 \text{ km}$$

Step 2 Mathematical expression

$$\frac{0.750 \text{ km}}{1} \times \frac{1{,}000 \text{ m}}{1 \text{ km}}$$

$$\frac{0.750 \text{ k}\cancel{\text{m}}}{1} \times \frac{1{,}000 \text{ m}}{1 \text{ k}\cancel{\text{m}}}$$

$$0.750 \times 1{,}000 \text{ m} = 750.0$$

EXERCISE G

My height is 170.0 cm. How tall am I in meters?

Step 1 Relationship between centimeters and meters

Step 2 Mathematical expression

EXERCISE H

Convert 1.392 m into millimeters.

Step 1 Relationship between millimeters and meters

Step 2 Mathematical expression

EXERCISE I

Convert 1.2 dm into centimeters.

Step 1 Relationship between decimeters and centimeters.

Step 2 Mathematical expression

B. Area

Area in the metric system is measured by the same method that it is measured in the English system. Area is equal to length x width (A = l x w). In the English system, we describe areas in terms of square inches, square feet etc. Mathematically a square inch means 1 in. x 1 in. = 1 in^2. Thus, the notation 1 m^2 means an area that is 1 meter long and 1 meter wide; 1 m x 1 m.

C. Volume

Volume is measured using the formula V = l x w x h. When we order redi-mix or fill-dirt it is quantified in terms of cubic yards. This means a cube that is 1 yard long, 1 yard wide, and 1 yard in height or 1 yd. x 1 yd. x 1 yd. = 1 yd^3. The basic unit of volume in the metric system is the cubic meter (m^3). This is a rather large volume and is not frequently used. A smaller unit of volume, the cubic decimeter (dm^3) is used, and it is also called the liter (l). (A liter or dm^3 is approximately 1.1 qt.). Another unit of volume frequently used is the milliliter (ml). One milliliter is equal to 0.001 liters, or there are 1000 ml's in 1 liter. Since one liter equals one cubic decimeter (dm^3) and 1 dm = 10 cm, we should be able to determine the number of cubic centiliters (cc) in 1 liter.

Step 1 1 dm = 10 cm

Step 2 1 l = 1 dm^3 = 1 dm x 1 dm x 1 dm

Step 3 substitute 10 cm for each dm

1 l = 10 cm x 10 cm x 10 cm

1 l = 1000 cm^3 or 1000 cc's

Therefore, 1 cc = 0.001 l

Since 1 ml is also 0.001 l, 1 cc is equal to 1ml

EXERCISE J

Convert 112.1 ml into liters.

EXERCISE K

Convert 5.75 l into ml's

EXERCISE L

Convert 10.0 cc into ml's.

EXERCISE M

Convert 1872.0 cc into liters.

D. Mass

The basic unit of mass ("weight") in the metric system is the gram (g) and there are approximately 26 g in 1 oz. A unit that is larger than the gram and is used to measure body weight is the kilogram (kg). One kilogram equals 2.2 pounds and 1 pound equals 454g. Two other units that are frequently used in science and medicine are the milligram (mg) and microgram (ug). These units are often employed in drug dosages.

EXERCISE N

Using your knowledge of prefixes, complete the following:

1 kg = _____g

0.001 g = _____mg

0.000001 g = _____ug

1 g = _____mg

1 g = _____ug

EXERCISE O

Convert 12.0 g into kilograms.

EXERCISE P

Convert 382.0 kg into grams.

EXERCISE Q

Convert 125.0 pounds to kilograms.

EXERCISE R

Convert 0.003 mg into micrograms.

EXERCISE S -- Food for thought

A patient weighs 220 pounds and you are to administer a drug in tablet form. Each tablet contains 1.0 mg of the drug. The instructions list the dosage in the following fashion:

30.0 ug per kilogram of body wt.

(This is a "tuffy" not everyone will get it.)

E. Temperature

Temperature in the metric system is measured in degrees centigrade or Celsius (^{o}C). The basis for this system is water. The temperature at which water boils is designated $100^{o}C$ and the point at which water freezes is $0^{o}C$. The formula to convert Fahrenheit temperatures (^{o}F) into Celsius is:

$$^{o}C = \frac{(^{o}F - 32)}{1.8}$$

For example, human body temperature is $98.6^{o}F$. To convert that temperature into Celsius units, we substitute 98.6 for ^{o}F and solve the equation.

$$^{o}C = \frac{(98.6 - 32)}{1.8}$$

$$^{o}C = \frac{66.6}{1.8}$$

$$^{o}C = 37.0$$

EXERCISE T

Convert room temperature $72^{o}F$ into degrees Celsius.

Celsius degrees can also be converted to Fahrenheit by using the following formula:

$$^{o}F = (^{o}C \times 1.8) + 32$$

If you see a bank sign that indicates its $10^{o}C$ outside, you would substitute 10 for ^{o}C and solve the equation:

$$^{o}F = (10 \times 1.8) + 32$$

$$^{o}F = (18.0) + 32$$

$$^{o}F = 50$$

EXERCISE U

What is the Fahrenheit temperature if the bank sign reads $-18^{o}C$?

The best way to learn temperature in the metric system is to remember a few temperatures such as the boiling point of water, the freezing point of water, human body temperature and room temperature. Use these as reference points and

guess temperatures in between. After all few of us could walk outside and pin point the temperature in degrees Fahrenheit today or in the dead of winter. If we want to know the exact temperature, we use a thermometer.

Answers to problems in the module:

Exercise A

776.0 x 100	=	77600.0	3/6	=	0.5
23.13 x 1000	=	24130.0	5/8	=	0.67
7.1 : 10	=	0.71	1/10	=	0.10
12.6 : 1000	=	0.0126	35/100	=	0.35
			57/1000	=	0.057

Exercise B

$$\frac{\$11.10}{1} \times \frac{100¢}{1}$$

$$\frac{\cancel{\$}11.10}{1} \times \frac{100¢}{\cancel{\$}1}$$

$$\frac{11.10}{1} \times \frac{100¢}{1}$$

$$11.10 \times 100¢ = 1100.0¢$$

Exercise C

Step 1 100 pennies = 1 dollar

Step 2

$$\frac{300¢}{1} \times \frac{\$\ 1}{100¢}$$

$$\frac{\overset{3}{\cancel{300¢}}}{1} \times \frac{\$\ 1}{\cancel{100¢}\ 1}$$

$$\frac{3}{1} \times \frac{\$1}{1}$$

$$3 \times \$1 = \$3.00$$

Answers to problems in Metric Module

Exercise D

Step 1 10 singles = 1 ten dollar bill

Step 2 $\frac{120 \text{ singles}}{1} \times \frac{1 \text{ ten}}{10 \text{ singles}}$

$\frac{\overset{12}{\cancel{120 \text{ singles}}}}{1} \times \frac{1 \text{ ten}}{\cancel{10 \text{ singles}}\ 1}$

$\frac{12}{1} \times \frac{1 \text{ ten}}{1}$

12 x 1 ten = 12 ten dollar bills

Exercise E

1,000,000	=	mega
1,000	=	kilo
0.100	=	deci
0.010	=	centi
0.001	=	milli
0.000001	=	micro

Exercise F

1 *km* = 1000 *m*

1 *m* = 10 *dm*

1 *m* = 100 *cm*

1 *m* = 1000 *mm*

1 *m* = 1,000,000 *μm*

Exercise G

Step 1 $100\ cm = 1\ m$

Step 2 $\frac{170.0\ cm}{1} \times \frac{1\ m}{100\ cm}$

$\frac{170.0\ \cancel{cm}}{1} \times \frac{1\ m}{100\ \cancel{cm}}$

$\frac{170.0 \times 1\ m}{100} = 1.70\ m$

Exercise H

Step 1 $1000\ mm = 1.0\ m$

Step 2 $\frac{1.392\ m}{1} \times \frac{1000\ mm}{1\ m}$

$\frac{1.392\ \cancel{m}}{1} \times \frac{1000\ mm}{1\ \cancel{m}}$

$1.392 \times 1000\ mm = 1392.0\ mm$

Exercise I

Step 1 $10\ cm = 1\ dm$

Step 2 $\frac{1.2\ dm}{1} \times \frac{10\ cm}{1\ dm}$

$\frac{1.2\ \cancel{dm}}{1} \times \frac{10\ cm}{1\ \cancel{dm}}$

$1.2 \times 10\ cm = 12.0\ cm$

Exercise J

Step 1 $1000\ m\ell = 1\ \ell$

Step 2 $\frac{112.1\ m\ell}{1} \times \frac{1\ \ell}{1000\ m\ell}$

$\frac{112.1\ \cancel{m\ell}}{1} \times \frac{1\ \ell}{1000\ \cancel{m\ell}}$

$\frac{112.1}{1} \times \frac{1\ \ell}{1000}$

$\frac{112.1 \times 1\ \ell}{1000} = 0.1121\ \ell$

Exercise K

Step 1 $1000\ m\ell = 1\ \ell$

Step 2 $\frac{5.75\ \ell}{1} \times \frac{1000\ m\ell}{1\ \ell}$

$\frac{5.75\ \cancel{\ell}}{1} \times \frac{1000\ m\ell}{1\ \cancel{\ell}}$

$5.75 \times 1000\ m\ell = 5750.0\ m\ell$

Exercise L

Step 1 $1\ m\ell = 1\ cc$

Step 2 $\frac{10\ cc}{1} \times \frac{1\ m\ell}{1\ cc}$

$\frac{10\ \cancel{cc}}{1} \times \frac{1\ m\ell}{1\ \cancel{cc}}$

$10 \times 1\ m\ell = 10\ m\ell$

Exercise M

Step 1 $1000\ cc = 1\ \ell$

Step 2 $$\frac{1872.0\ cc}{1} \times \frac{1\ \ell}{1000\ cc}$$

$$\frac{1872.0\ \cancel{cc}}{1} \times \frac{1\ \ell}{1000\ \cancel{cc}}$$

$$\frac{1872.0 \times \ell}{1000} = 1.872\ \ell$$

Exercise N

$$1\ kg = 1000\ g$$

$$0.001\ g = 1\ mg$$

$$0.000001\ g = 1\ \mu g$$

$$1\ g = 1000\ mg$$

$$1\ g = 1{,}000{,}000\ \mu g$$

Exercise O

Step 1 $1000\ g = 1\ kg$

Step 2 $$\frac{12.0\ g}{1} \times \frac{1\ kg}{1000\ g}$$

$$\frac{12.0\ \cancel{g}}{1} \times \frac{1\ kg}{1000\ \cancel{g}}$$

$$\frac{12.0 \times 1\ kg}{1000} = 0.012\ kg$$

Exercise P

Step 1 $1000\ g = 1\ kg$

Step 2 $\frac{382\ kg}{1} \times \frac{1000\ g}{1\ kg}$

$\frac{382\ \cancel{kg}}{1} \times \frac{1000\ g}{1\ \cancel{kg}}$

$382.0 \times 1000\ g = 382000.0\ g$

Exercise Q

Step 1 $2.2\ lbs = 1\ kg$

Step 2 $\frac{125\ lbs}{1} \times \frac{1\ kg}{2.2\ lbs}$

$\frac{125\ \cancel{lbs}}{1} \times \frac{1\ kg}{2.2\ \cancel{lb}}$

$\frac{125 \times 1\ kg}{2.2}$

$\frac{125\ kg}{2.2} =$

Exercise R

Step 1 $1000\ \mu g = 1\ mg$

Step 2 $\frac{0.003\ mg}{1} \times \frac{1000\ \mu g}{1\ mg}$

$\frac{0.003\ \cancel{mg}}{1} \times \frac{1000\ \mu g}{1\ \cancel{mg}}$

$0.003 \times 1000\ \mu g = 3.0\ mg$

Exercise S

Step 1 2.2 lbs = 1 *kg*

1000 µg = 1 *mg*

**note parenthesis ( ) indicates multiplication

Step 2 $\left(\frac{220 \text{ lbs}}{1}\right)\left(\frac{1 \text{ kg}}{2.2 \text{ lbs}}\right)\left(\frac{30 \text{ µg}}{1 \text{ kg}}\right)\left(\frac{1 \text{ mg}}{1000 \text{ µg}}\right)\left(\frac{1 \text{ tablet}}{1 \text{ mg}}\right) =$

Exercise T

°C = (72 - 32)

°C = $\frac{40}{1.8}$

°C = 22.2 or approximately 22°C

Exercise U

°F = (-18 x 1.8) + 32

°F = (-32.4) + 32

°F = -.4 or approximately 0°F

SELF TEST for Metric Module

1. List the basic units of measurement of the metric system and indicate what they measure.

2. Write the word indicated by the following abbreviations:

m = _____

dm^3 = _____

g = _____

^oC = _____

3. Define the following prefixes and write their abbreviations.

kilo _____

deka _____

deci _____

centi _____

milli _____

micro _____

SELF TEST
page 2

4. Convert the following lengths.

   a. 1.72 cm = _____ mm

   b. 13.75 dm = _____ m

   c. 8964 m = _____ km

   d. 7523.0 mm = _____ m

5. Convert the following volumes.

   a. 1 dm^3 = _____ l

   b. 1.37 l = _____ ml

   c. 250.0 cc = _____ l

   d. 17.0 ml = _____ l

6. Convert the following masses.

   a. 200.0 kg = _____ g

   b. 2.758 kg = _____ g

   c. 81.02 g = _____ mg

   d. 1.0003 g = _____ mg

   e. 173.0 g = _____ kg

7. One pound = _____ g.

8. One kilogram = _____ pounds.

SELF TEST
page 3

9. Human body temperature = _____ ^{o}C.

10. Boiling point of water = _____ ^{o}C.

11. Freezing point of water = _____ ^{o}C.

12. Ten feet is approximately _____ m.

13. One pint is approximately _____ l = _____ ml.

14. 100 pounds is approximately _____ kg.

15. 45^{o}F is approximately _____ ^{o}C.

wkshop.met

WORKSHOP IN BASIC SCIENCE

THE MICROSCOPE

Clete Brummel
Biology Department
Lake Michigan College

Goals

The student will be able to use the microscope proficiently.

Objectives

Upon completion of this module and attending lecture, the student should be able to perform the following with 70% mastery.

1. Write a definition of a compound microscope and a simple microscope.
2. Write a definition of magnification and resolution.
3. Explain in writing the relationship between the color of light and resolution.
4. List the three critical user-controlled factors that determine the quality and clarity of a microscopic image.
5. Identify the parts of a microscope on a drawing and/or an actual microscope.
6. State in writing the function of each part of the compound microscope.
7. Write a definition of depth of field, focal plane, and field of view.
8. Explain in writing the relationship between magnification and depth of field.
9. Explain in writing the relationship between magnification and field of view.
10. Write a definition of parfocal.
11. Calculate the total magnification of any combination of objectives and ocular powers.
12. In writing, list the steps necessary to view a specimen under the microscope (min. 8 steps).
13. Describe in writing the correct procedure for returning a microscope to storage.
14. Describe in writing the correct procedure for carrying a microscope.
15. Construct pencil drawings of microscopic specimens that are accurate and complete; drawn neatly, labeled correctly and correctly proportioned.

Instructions

This module is divided into sections. Each section covers one concept or topic that is a component of the microscope and has several exercises that enable you to test yourself over the material in each section. Work through each exercise and check your answer with those provided on the white sheets (p. 19, 20). After you complete the entire module, take the self-test. The answers to it will be provided in class the following day. Also in class the following day, there will be a lab period with several "hands-on" activities that will enable you to use the microscope and construct drawings.

Introduction

The microscope is the basic instrument used for studying the appearance and structure of cells and tissues. The cell is the fundamental unit of all living systems, and each type of tissue is composed of many cells which are specialized to perform a particular function. The function of a tissue and its cells is related to its structure, and this structure is visible only with a microscope. Therefore, acquiring the knowledge and skill necessary for proper use of the microscope is one of the most important laboratory techniques required in biology.

Part I -- History

The microscope is probably the oldest instrument used by biologists. The first microscopes were made in Holland during the late 1500's and early 1600's. These microscopes had only a single lens and were called simple microscopes. These simple microscopes were used through the early 1800's. During the period of time from 1820-1870's, several breakthroughs occurred in the mathematical design and grinding of lenses. Those new techniques enabled compound microscopes to surpass in quality the simple microscopes. The compound microscope employed two lenses rather than one. Thus the image of the specimen passed through a first lens and then a second lens. Figure 1 illustrates the difference between simple and compound microscopes.

FIG.1

SIMPLE MICROSCOPE

COMPOUND MICROSCOPE

EXERCISE A

1. In your own words, define the following:

   a. simple microscope

   b. compound microscope

Part II -- Characteristics of Microscopes

A. Magnification and Resolution

The quality of any microscope is determined by two factors, magnification and resolution. Magnification is defined as "an apparent increase in size especially through the use of lenses." Resolution or resolving power is defined as "the ability to distinguish two points (that are very close together) as two distinct and separate points." It is resolving power that enables the observer to see fine details in a specimen. Of these two factors, it is resolving power that determines the quality of a microscope, because high magnification with poor resolution results in a large, fuzzy, blurred image with no fine detail visible.

Resolving power itself is a function of several factors; the two most important are the precision of lens grinding and the quality of the light used to illuminate the specimen. Grinding lenses is an art, and the finer the lenses

the more costly the microscope will be. The quality of light refers to its color (wave length) and the degree to which the light beam is bent and scattered (increase in diameter of light beam). Red light is the poorest color for microscope work and-blue to violet is the best. Most microscopes are equipped with a blue/violet filter that converts white light into the correct color. High resolution is also obtained by using a straight, narrow beam of light, and anything that bends or scatters the light will decrease the resolution.

EXERCISE B

1. In your own words define the following:

   a. magnification

   b. resolution (resolving power)

2. Why would a scratch on a lens decrease resolution?

B. Light

Since light is so critical to good resolution, one of the most important factors in microscopy is clean lenses. Any smudge or dirt on a lens or microscope slide will impair the transmission of light, and the result is a cloudy, fuzzy image. This is also the easiest factor to control. Before you use a microscope, clean all the lenses with lens paper and clean the microscope slide. Usually dry lens paper is adequate; but if the surface is greasy, the lens paper should be moistened with alcohol and then dried with a new piece of lens paper. If you wear glasses, dirty glass lenses will also interfere with your ability to see a clear image. (Some people remove their glasses when using a microscope).

Equally important is the amount of light that passes through the specimen and the intensity of the light. Microscopy is similar to photography. Too much light (over exposure) results in a faded image with no detail visible due to lack of contrast. Insufficient light (under exposure) results in an image that is too dark for details to be visible. The microscope is equipped with a device called an iris diaphragm which is operated by a lever and regulates the amount of light that reaches the specimen. The iris diaphragm is similar to a camera shutter and adjusts the amount of light by forming an aperature that ranges in diameter from the size of a pencil point to a half dollar.

EXERCISE C

1. As you are using the microscope, you notice tiny black specks in the field of view. What would you do to correct this?

2. As you are using the microscope, the image is very blurred. What would you do to correct this?

3. What is the function of the iris diaphragm?

4. What is the function of the rheostat switch?

C. Parts of the Microscope (Figures 1-0 and 1-1)

The microscope is supported by a large heavy base. The light source is in the base of the microscope and the rheostat switch is on one side of the base. The light source is enclosed by the base and a lens which can collect grease and dust. The light passes from the light source up through the iris diaphragm and the condenser lens. The condenser lens is cone shaped and refocuses the light into a narrow beam before it reaches the specimen. This lens can also become dirty.

The specimen is mounted on the large flat stage by a device called a mechanical stage. The microscope slide fits in between the "arms" of the mechanical stage not under the "arms." Slight pressure holds the slide in place. In addition to the "arms" the mechanical stage is equipped with a gear mechanism that is operated by two knobs. Turning one knob provides for forward and backward movement of the slide across the stage and the other knob allows side to side movement.

A mechanical stage enables you to move a slide a microscopic distance; whereas most fingers are not adept at moving an object a microscopic distance. After the light passes through the microscope slides, it is transmitted through one of four objective lens. Each objective lens is mounted in a metal tube called an objective that is attached to a revolving nose piece. The nose piece allows you to rotate different objectives into the light path. Each objective contains a lens of different magnifying power, and the magnifying power is directly related to the length and size of the objective. The magnification of each objective is stamped on the outside of the tube and it is indicated with a number followed by an "X". For example "4X" means that the apparent size of the specimen is increased four times. The shortest and least powerful objective is called the scanner. The next is called low power, the third objective is the

high dry, and the largest and most powerful is the oil immersion. (The oil immersion objective must be immersed in a special oil or its resolving power is poor. We rarely use oil immersion.)

Each brand and model of microscope is equipped with slightly different magnifications. Usually the scanner ranges from 4X - 5X, the low power 10X, the high dry 40X - 45X, and the oil immersion 95X - 100X. Thus instead of memorizing the magnification of each objective, it is more beneficial to learn the name, i.e. scanner, etc. and be able to find the power stamped on each one.

After the image is magnified by an objective lens, it passes through the nose piece, into the rotating eye piece (ocular), and is magnified by the ocular lens. The standard magnification of the ocular lens is 10X. The total magnification is determined by multiplying the objective power by the ocular power. Also within the eye piece is a pointer that can be moved by rotating the ocular or moving the slide. Thus you can "point" to an object by rotating the eye piece and maneuvering the slide with the mechanical stage.

The last important parts of the microscope are the coarse and fine adjustment knobs. These two knobs are focusing devices, and they function by raising and lowering the stage. The coarse adjustment knob, (the largest) is used only when the scanning lens is in place. The fine adjustment knob is used to focus the image when the other objectives are in place. Never use the coarse adjustment to focus when the low power, high dry or oil immersion objectives are in place! Using the coarse adjustment with these objectives could break a microscope slide and/or scratch an objective lens.

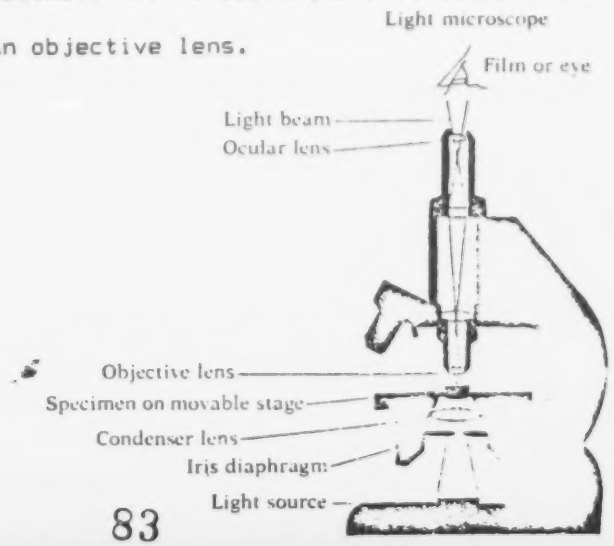
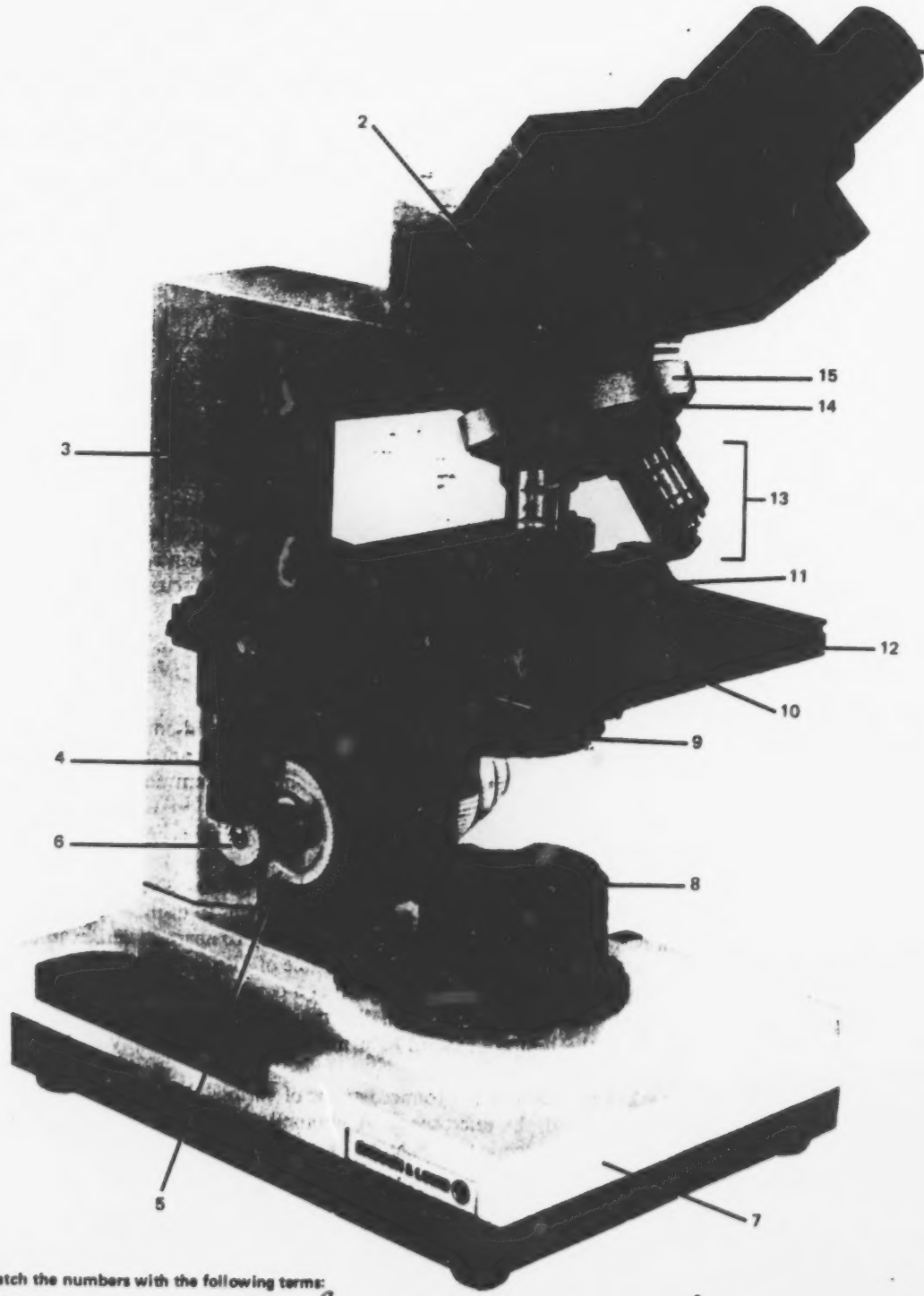


Figure 1-0



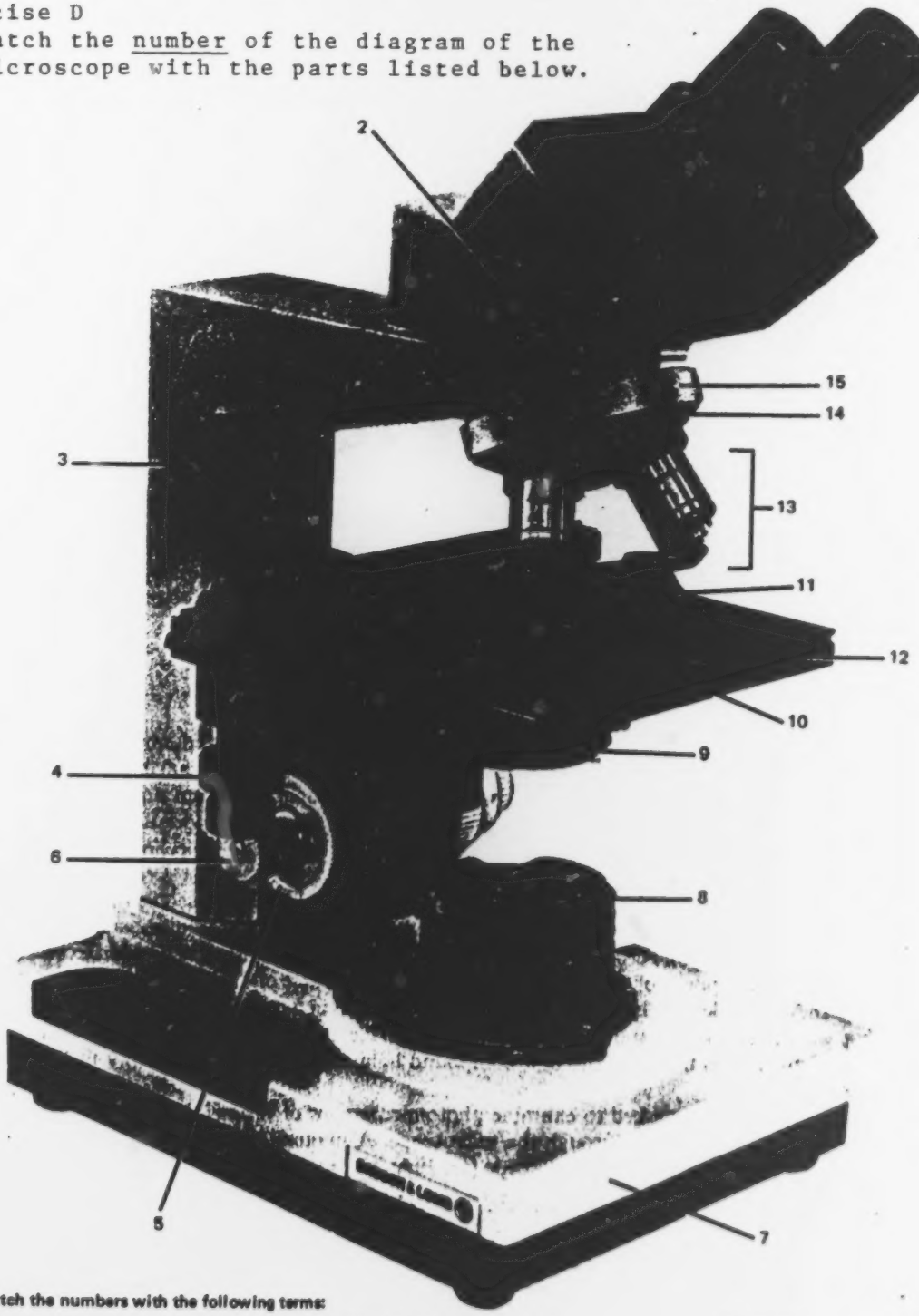
Match the numbers with the following terms:

3 Arm	9 Diaphragm	13 Objectives
7 Base	6 Fine adjustment knob	1 Ocular
2 Body tube	8 Light	15 Revolving nosepiece
5 Coarse adjustment knob	4 Mechanical stage knob	12 Stage
10 Condenser	14 Nosepiece	11 Stage clip of mechanical stage

Figure 1-1 Galen™ II microscope. (Courtesy of Bausch & Lomb, Rochester, New York.)

Exercise D

1. Match the number of the diagram of the microscope with the parts listed below.



Match the numbers with the following terms:

__ Arm	__ Diaphragm	__ Objectives
__ Base	__ Fine adjustment knob	__ Ocular
__ Body tube	__ Light	__ Revolving nosepiece
__ Coarse adjustment knob	__ Mechanical stage knob	__ Stage
__ Condenser	__ Nosepiece	__ Stage clip of mechanical stage

Figure 1-1 Galen™ II microscope. (Courtesy of Bausch & Lomb, Rochester, New York.)

EXERCISE D (continued)

2. What is the range of total magnification for a microscope equipped with a 10X ocular and the following objectives:

   a. scanner = 4X

   b. low power = 10X

   c. high dry = 40X

   d. oil immersion = 100X

3. What is the function of the condenser lens?

4. What is the advantage of a mechanical stage?

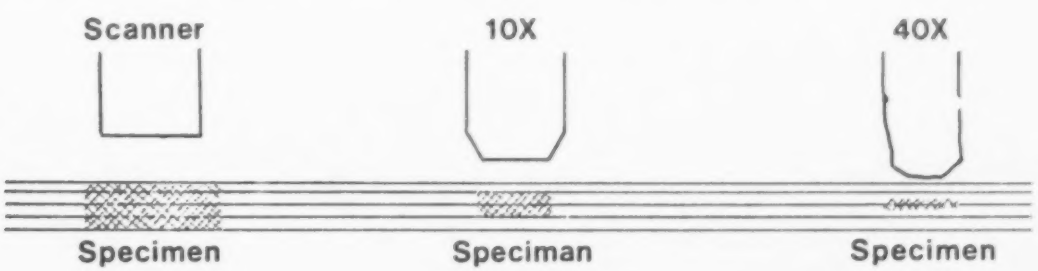
5. What is the function of the coarse adjustment? (When do you use it?)

6. What is the function of the fine adjustment? (When do you use it?)

D. Depth of Field and Field of View

Once a specimen is in coarse adjustment under the scanner, it is also coarsely adjusted for the other three objectives, and usually a slight turn of the fine adjustment will bring the object into sharp focus. This property of remaining in coarse focus is called parfocal. Switching from a low power objective to a higher power does not alter the focal plane, but it narrows the depth of field and decreases the field of view. In photography the depth of field is the total distance that is in sharp focus on the photograph and the center of that distance is the focal plane. The total area within the photo is the field of view. Similarly, in microscopy, the depth of field is the thickness or number of layers of a specimen that is in sharp focus, and the focal plane is the center of that thickness. The field of view is the area of the slide that is visible through the microscope.

Increasing the magnification (fig. 3) decreases the depth of field, but the focal plane remains the same. In the illustration, the bottom of layer two is the focal plane. If an object is viewed with the scanner in layer four, it is in sharp focus as is anything in layers 1-4. However, when the 10X objective is in place, an object in layer 4 is no longer in sharp focus; only objects in layers 2-3 are in sharp focus. To bring the object in layer 4 into focus requires a slight turn of the fine adjustment. Thus another way of defining parfocal is that the focal plane does not change when objectives are changed.



shade= thickness that is 'in focus' for each objective.

FIG.3 DEPTH OF FIELD AND INCREASED MAGNIFICATION

A relationship also exists between magnification and the field of view. The field of view is the illuminated, circular area of the slide that is visible through the microscope, and it has one central point. Increasing the magnification (fig. 4) does not alter the center of the field of view, but it does decrease the area of the slide that is visible. The region that is visible remains circular, has the same central point, but the area is decreased. Thus it is important that the object be in the center of the field of view before changing from a low power objective to a high power. If it is not in the center, it may "disappear" from the field of view. (Note the "X" in fig. 4).

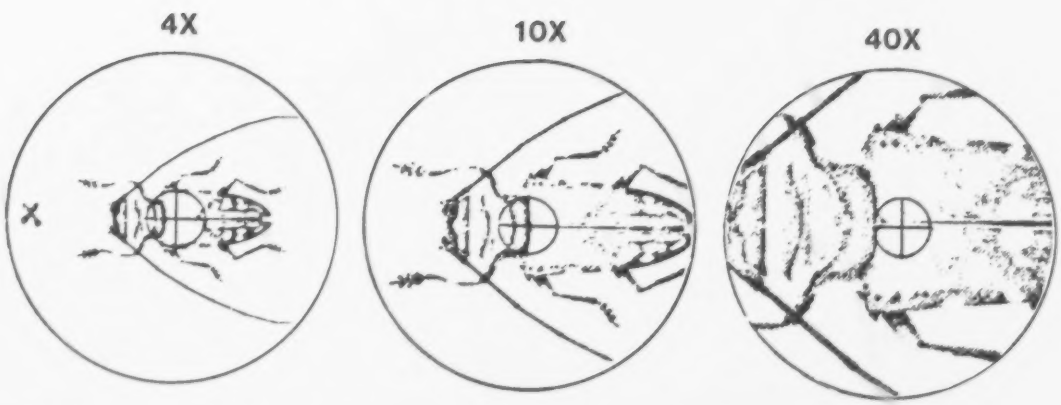


FIG. 4 FIELD OF VIEW AND INCREASING MAGNIFICATION

EXERCISE E

1. Define the following:

   a. depth of field

   b. focal plane

   c. field of view

2. If an object is in the top of the field of view on the scanner, will it be visible through the scope on the low power? Why, or why not?

3. Why is it necessary to only adjust the fine adjustment when switching from low power to high dry?

Part III -- Procedure for Using a Microscope

1. Carry the scope with two hands. One hand supports the base; the other hand grasps the arm. Never carry a scope with the cord trailing on the floor. The cord should be wrapped around the base.
2. Clean all the lens and the microscope slide. Finger prints on slides greatly reduce the resolution.
3. Make sure that the stage is in its lowest position, the scanner is in place, and the iris diaphragm is "closed."
4. Check the light switch. It should be in the "off" position when you plug the scope in the socket. A sudden surge of current could "blow out the bulb. (Bulbs are cheap but it's a hassle to change them and time consuming.)
5. Plug the scope in and turn the switch to "on."
6. Mount the slide in the mechanical stage.
7. Position the specimen in the center of stage above the condenser lens.
8. Slowly raise the stage as far as it will go.
9. While looking in the ocular, slowly lower the stage with the coarse adjustment knob. The specimen will suddenly appear. Continue focusing with the coarse adjustment until the image is sharp and clear. At this point adjust the amount of light with the diaphragm.
10. Using the mechanical stage, center the specimen in the field of view.
11. Rotate the nose piece so that the low power objective clicks in place.
12. Focus with the fine adjustment until the image is clear and sharp. Also adjust the amount of light with the diaphragm.
13. Center the specimen.
14. Rotate the nose piece so that the high dry objective (40X) clicks in place.
15. Focus with the fine adjustment until the image is sharp and clear. Also adjust the amount of light and the intensity of the light.

After using the microscope several times, the above steps become automatic. Always remember the critical role light plays in microscopy and to use the course adjustment only when the scanner is in place.

When you have finished with the microscope it should be returned to the cabinet and placed in the correct space. A correctly stored microscope has the light switch off, the cord wrapped up, the scanner in place, the stage at the lowest level, and the stage empty (no slide in place).

Part IV -- Drawings

When a microscope is utilized in biology, you are doing much more than just looking. You are studying a cell or tissue, and you will be expected to recall important details of that cell or tissue, The best way to study with a microscope is to construct drawings of the specimen. To construct an accurate drawing it is necessary to make careful observations of fine details of the specimen and neatly express those observations on paper. A drawing is not based on artistic talent, but on accuracy. An accurate lab drawing includes neatness, correct labeling, correct spelling, and correct proportion.

All drawings should be done in pencil and include in the lower right hand corner the following information: student's name, lab day and time, name of specimen and date. See attached example.

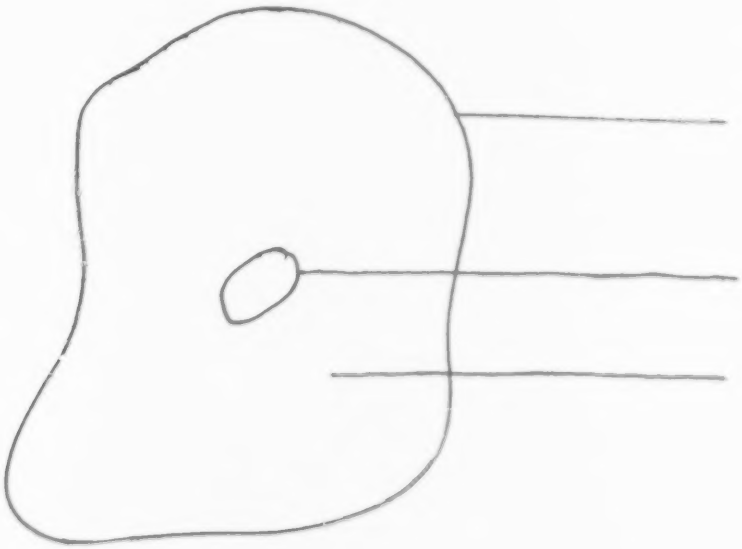
Laboratory Drawing Instructions

In order to have an acceptable drawing, follow these suggestions:

1. Make drawing large enough so that all parts can be clearly seen and labelled.
2. Make drawing from your slide or specimen. Do not copy out of textbook.
3. Use ruler to draw label lines.
4. Print labels and be sure spelling is accurate.
5. Use pencil.

The drawings grade will be based on:

1. Neatness
2. Accuracy
3. Appropriate proportions
4. Completeness
5. No spelling errors



Each page of drawings should have the following information:

Name _____
Lab Day and Time _____
Date _____
Species _____
Item drawn _____

Answers to Exercises
Microscope Module

Exercise A

1. A simple microscope magnifies the image through one lens.
2. A compound microscope magnifies the image through two lenses.

Exercise B

1. a. Magnification is an increase in the size of an object.
   b. Resolution is the ability to distinguish two objects as two separate objects.
2. A scratch would bend the light beam.

Exercise C

1. Clean the lenses and the microscope slide (and your glasses if you wear them).
2. Same as #1.
3. The iris diaphragm regulates the amount of light.
4. The rheostat switch regulates the intensity of light.

Exercise D

1. Check yourself with the labeled diagram.
2. a. 4 x 10 = 40X
   b. 10 x 10 = 100X
   c. 40 x 10 = 400X
   d. 100 x 10 = 1000X
3. The condenser lens refocuses the light into a narrow straight beam.
4. The mechanical stage enables a slide to be moved very short distances.

Answers to Exercises
Microscope Module

5. The coarse adjustment is used to focus when scanner only is in place.

6. The fine adjustment is used to focus when low power, high dry and oil immersion objectives are in place.

Exercise E

1. a. Depth of field is the distance or thickness that is in sharp focus.

   b. The focal plane is the center of the depth of field.

   c. The field of view is the area of a slide that is visible through the microscope.

2. It will not be visible because the field of view decreases and the object is not within the field of view under the low power.

3. Microscopes are parfocal and once it is coarsely adjusted, it remains coarsely adjusted.

Self Test
Microscope Module

1. Compare and contrast a simple microscope and a compound microscope.

2. What is the function of the iris diaphragm?

3. What is the function of the condenser lens?

4. Define magnification.

Self Test
Microscope Module
page 2

5. Define resolution.

6. What are three user-controlled factors that determine resolution?

7. What is the relationship between increasing magnification and the field of view?

Self Test
Microscope Module
page 3

8. What is the relationship between increasing magnification and the depth of field?

9. What is the total magnification if the ocular is 15X and the objective is 10X?

10. List several steps necessary to view an object under high dry.

Self Test
Microscope Module
page 4

11. How should a microscope be stored?

12. How should a microscope be carried?

Lab Activities
Microscope Module

Part I -- Parts of the Microscope

Activity A

Get a microscope from the cabinet and carrying it properly, return to the lab table. Examine the condition of the scope as you found it. Did the person who last used it put it away properly? _____ If not, what was wrong?

Activity B

Locate and examine each part of the microscope. Operate these parts to "get the feel" for how they work. Rotate the objectives, click each one in place and return to the scanning lens. Rotate the coarse adjustment knob and then the fine adjustment knob. Adjust the diaphragm level and observe what happens to the size of aperature as the lever is moved from right to left and left to right. Last, turn the knobs that move the mechanical stage. Determine which knob moves the slide from front to back and which one moves the slide from left to right.

Activity C

Locate the objectives. What is the magnification of each objective?

a) scanning =

b) low =

Lab activities
Microscope Module
page 2

Activity C (continued)

What is the magnification of each objective?

c) high dry =

d) oil =

Calculate the total magnification for each objective.

a) scanning =

b) low =

c) high dry =

d) oil =

Part II -- Using the Microscope

Place the drawings in the spaces provided.

Activity A

1. Obtain a prepared slide containing the printed letter "e" under the cover glass. Note that you can red the letter with the naked eye.
2. Draw the letter as it normally appears on the slide (DRAWING A).
3. Place the slide on the stage of the microscope so that the letter is in the same relative position as when observed in No. 2.

4. Look in the microscope under scanning and draw the letter as it appears to you (DRAWING B).

(Drawing A) (Drawing B)

5. Move the slide so that the letter appears in the upper left corner of the field. Now, center the letter while looking through the microscope. In which directions did you move the slide? _____

Activity B. Newspaper Slide

PROCEDURE

1. Obtain a newspaper slide (approximately 1 in. × 3 in. piece with printing on its surface).
2. Draw an asymmetrical letter as it normally appears on the paper slide (DRAWING A).
3. Place the slide on the stage of the microscope so that the asymmetrical letter is in the same relative position as when observed in No. 2.
4. Look in the microscope under low power and draw the letter as it appears to you (DRAWING).

(Drawing A) (Drawing B)

5. Move the slide so that the letter appears in the upper left corner of the field. Now, center the letter while looking through the microscope. In which directions did you move the slide? _____

Activity C. Thread Slide

DISCUSSION

This exercise requires careful technique. It demonstrates the fact that objects viewed through a microscope are three-dimensional, and that detail exists at varying levels which can only be observed by careful manipulation of the fine adjustment knob.

PROCEDURE

1. Obtain a prepared slide containing three colored, crossed threads.
2. Begin with the slide slightly out of focus below the three threads, using the scanner objective.
3. Using the fine adjustment knob clockwise, adjust the stage of the microscope down until the bottom thread comes into focus, then the middle thread then the upper thread. Repeat this procedure until you have determined the correct sequence of the threads. (Use the scanner objective, then check the results with the low power objective.)
4. Record your observations in the spaces provided below.
   a. Color of thread on bottom _____ Slide letter _____
   b. Color of the middle thread _____
   c. Color of thread on top _____
5. Have the instructor check your results.

Approved _____

Activity D

We're finished! Please put the microscope away following the rules for proper and safe care of the instrument.

WORKSHOP IN BASIC SCIENCE

BIOLOGICAL SCIENCE

Clete Brummel
Biology Department
Lake Michigan College

Goal

Students will become familiar with the levels of structure and complexity in the biological sciences.

Objectives

Upon completion of this module and attending lecture, the student should be able to complete the following with 70% mastery.

1. In writing, list the characteristics of a living system.
2. In writing, list the correct order of the structural levels of a living system.
3. Write a definition
4. In writing, describe a cell.
5. List the components of the cell theory.
6. Write a definition of cell membrane.
7. Write a definition of cytoplasm.
8. Write a definition of cellular organelle.
9. Write a definition of the cellular nucleus.
10. Write a definition of tissue.
11. List the four general classes of tissues.
12. List the functions of epithelial tissue.
13. List the functions of muscle tissue.
14. List the functions of nervous tissue.
15. In writing, describe connective tissue.
16. List the functions of connective tissue.

Instructions

This module is divided into sections. Each section covers one concept or topic and has several exercises that will enable you to test yourself over the material in each section. Work through each exercise and check your answer with those provided on the yellow sheets. After you complete the entire module, take the self-test. The answers to it will be provided in class the following day. Also in class the following day there will be a lab period with several microscope slides that have prepared specimens of each class of tissue.

Introduction

All living systems exhibit certain characteristics that enable them to be classified as living. All living systems are complex in their structure, and the basic unit of a living system is the cell. No human engineered device has the complexity of structure that one cell has. Living systems are capable of reproducing themselves or self duplicating. Metabolism is a characteristic of a living organism. Metabolism is the sum total of chemical and energy reactions that occur in the organism. There are two aspects to metabolism; catabolism (breakdown) and anabolism (synthesis). Living organisms respond and adapt to fluctuations in their environment. A living system grows and develops over time through the process of assimilation. Growth is an increase in number and size and development is a change that occurs over the life span of the organism. Assimilation is the process whereby a living organism converts non-living matter into living matter. Living systems exhibit all of these characteristics. If a system or thing does not exhibit all of them, it is not living.

EXERCISE A

List the characteristics of life.

Part I -- Structural Levels

Living organisms are complex in their structure and function. In order to simplify the task of studying and understanding life, biologists organize life into levels of structural complexity. This organization begins with the simplest structure first and each successive level is a complex grouping of the preceding level.

1. Atom -- Living systems are composed of matter and the simplest structural unit of all matter is the atom.

2. Molecule -- The molecules synthesized by a living system are extremely in structure.

3. Organelle -- An organelle is a component of a cell. Each organelle is composed of several thousand molecules and it is structured to perform a specific function for the cell. For example, an organelle called a mitochondria performs the function of catabolism.

4. Cell -- The cell is the basic unit of life. One cell is capable of performing all the functions of life.

5. Tissue -- A tissue is a group of similar cells that due to their structure, perform one or two functions for the organism.

6. Organ -- An organ is a group of tissues that performs one or two functions for the organism.

7. Organ System -- An organ system is a group of organs that performs one or more vital functions for the organism.

8. Organism -- An organism is one individual of a given species.

EXERCISE B

List the correct sequence of the structural levels of an organism and define each level.

1.

2.

3.

4.

5.

6.

7.

8.

Part II -- The Cell

One of the fundamental principles of biology is the cell theory. This theory has three components that have developed over the course of several decades. The first statement in the cell theory is that the cell is the basic unit of life. This means that the cell is the simplest structure that performs all the functions and characteristics of life. Secondly, the cell theory states that all cells arise from pre-existing cells. In other words, non living matter does not suddenly becoming living. The third component states the cell carries genetic information.

Every human cell consists of an outer living cell membrane which encloses a gelatin-like substance called cytoplasm. Within the cytoplasm are many organelles ("little organ") that each perform a vital function within the cell. The largest organelle of human cells is the nucleus. The nucleus is separated from the cytoplasm by a nuclear envelope or membrane. Within the nucleus is a granular appearing substance termed chromatin. Chromatin is composed of DNA molecules and it appears darker than the cytoplasm. Also within the nucleus is a darker region than the chromatin. This darker region is the nucleolus and it is composed of RNA. The function of the nucleus is to regulate all of the cell's activities; the nucleus is the cell's control center. The other organelles within the cytoplasm are not readily observed with a light microscope.

EXERCISE C

1. What does the cell theory state?

EXERCISE C (continued)

2. What is the outer living boundary of a cell?

3. What is cytoplasm?

4. What is the function of the nucleus?

5. How is the contents of the nucleus separated from the cytoplasm?

Part III -- Tissues

The cells of human beings are grouped into tissues. The tissues are classified based on the function of the tissue, and the structural organization of the tissue. The four classes of tissues are: epithelial tissue, muscle tissue, nerve tissue, and connective tissue. Within each class of tissue, there are several individual tissue types based on the function and structure of the specific type. For example, muscle tissue has three specific types; skeletal, cardiac, and smooth. Each of these three has a unique function and recognizable structure.

Epithelial tissue is the class of tissues that covers and lines the body. This tissue is composed of very tightly fitting cells with no space between the cells and no extracellular substance. The outer layer of skin is epithelial tissue and the lining of the heart, the bladder, etc. The function of epithelial tissue is threefold; protection, absorption and secretion. The function of the tissue determines its structure. Structurally epithelial tissue is divided into two subclasses; simple (non layered) and stratified (many layers). Within each subclass the tissues are further categorized based on the shape of the cells. Stratified tissues are present where body structures require protection. Simple tissues are present where the processes of absorption and secretion occur. (Absorption is the process of transfer of material across and through a cell. Example: Oxygen is transferred across and through cells of the lung and into a blood vessel.)

EXERCISE D

1. Name the four classes of tissues

EXERCISE D (continued)

2. Define a tissue.

3. List the function of epithelial tissue.

4. What would the function of stratified squamous epithelium be?

Muscle tissue is characterized by the property of irritability and contractibility. Irritability means that muscle tissue responds to a stimulus specifically an electrical stimulus, and contractibility means that muscle tissue can shorten in length. Muscle cells are long and slender and the most abundant substance in muscle cells is protein. The function of all muscle tissue is movement. Skeletal muscle moves bones, cardiac muscle moves blood, and smooth muscle moves material through tubes in the body such as the intestine. All muscle tissues are composed of the same protein, but the type of muscles are unique due to the manner in which the proteins are organized.

Nerve tissue carries on the most complex function in the body, yet all nerve tissue consists of one type of cell, the neuron. The neuron is the cell that is capable of conducting an electrical chemical current which is called an impulse.

EXERCISE E

1. What is the function of muscle tissue?

2. What molecule (chemical) makes up muscle tissue?

3. What is the function of nerve tissue?

The last category of tissues is connective tissue and it is a mixture of functional types. Tissues are classified as connective if they fit the description of connective tissue. Connective tissue is described as a tissue that has living cells embedded in a non-living matrix (intracellular material). Usually the matrix is the most abundant component and the functional component of the tissue. Connective tissues are classified based on the type of matrix

present and the abundance and type of cells present. There are three subclasses of connective tissue; connective tissue proper, cartilage, and special connective tissues. Each of these subclasses is further subdivided into very specific tissues. For example, white fibrous connective tissue is the major tissue of a tendon and it is a connective tissue proper. Vertebral discs are composed of fibrous cartilage, and bone is a special connective tissue. The general function of a connective tissue is to support and maintain the form of the body and its organs.

EXERCISE F

1. What are the 2 components of a connective tissue?

2. On what basis are connective tissues categorized?

3. What is the function of connective tissues?

Answers to Exercises
Biological Science Module

Exercise A

1. Complex structure
2. Reproduction
3. Metabolism
4. Respond and adapt
5. Grow and develop

Exercise B

1. Atom simplest structure of an element
2. Molecule group of atoms
3. Organelle -- component of cell performs a function
4. Cell -- basic unit of life
5. Tissue -- group of similar cells which perform a function
6. Organ -- group of tissues which perform a function
7. Organ system -- group of organs which perform a vital function
8. Organism -- one individual of a species

Exercise C

1. Cells are the basic unit of life; cells arise from other cells; cells carry genetic information.
2. The cell membrane.
3. Gel-like substance inside the cell.
4. Nucleus regulates all of the cell's activities.
5. The nuclear membrane separates the nucleus from the cytoplasm.

Answers to Exercises
Biological Science Module

Exercise D

1. Epithelial tissue, muscle tissue, nerve tissue, connective tissue.
2. Group of similar cells which perform a function.
3. Protection, absorption, secretion.
4. Protection.

Exercise E

1. Movement.
2. Protein.
3. Conducting impulses.

Exercise F

1. Cells and non-living matrix.
2. Type of matrix and type and number of cells.
3. Support and maintain body form.

Self Test
Biological Science Module

1. What are the characteristics of life?

2. Define an organelle.

3. Define a tissue.

4. Write a description of the cell.

Self Test
Biological Science Module
page 2

5. What are the four categories of tissues?

6. What is the function of each class of tissues?

Lab Activities
Biological Science Module

Activity A

Obtain a representative slide of epithelial tissue and observe it under the microscope. Use the textbook provided as a reference to draw and label the specimen.

Activity B

Obtain a representative slide of muscle tissue and observe it under the microscope. Use the textbook provided as a reference to draw and label the specimen.

Activity C

Obtain a representative slide of connective tissue proper and observe it under the microscope. Use the textbook provided as a reference to draw and label the specimen.

Activity D

Obtain a representative slide of cartilage tissue and observe it under the microscope. Use the textbook provided as a reference to draw and label the specimen.

wkshop.bio

WORkSHOP IN BASIC SCIENCE

HUMAN ORGAN SYSTEMS

Clete Brummel
Biology Department
Lake Michigan College

Goal

The student will become familiar with human anatomy and in particular the human skeletal system.

Objectives

Upon completion of this module and attending lecture, the student should be able to complete the following with 70% mastery.

1. List all the organ systems of the human body.
2. In writing, give a brief description of the function of each system.
3. In writing, define articulation.
4. In writing, classify any bone as a long, flat or irregular.
5. List the two divisions of the skeletal system.
6. Name the bones of the skull.
7. Define and name the bones of the spine.
8. Define and name the bones of the pectoral girdle.
9. Define and name the bones of the pelvic girdle.
10. Name the bones of the arm.
11. Name the bones of the hand.
12. Name the bones of the leg.
13. Name the bones of the foot.
14. Identify any human bone in an articulated skeleton or any disarticulated bone.

Instructions

This module is divided into sections. Each section covers one concept or topic and has several exercises that enable you to test yourself over the material in each section. Work through each exercise and check your answer with those provided on the yellow sheets. After you complete the entire module, take the self-test. The answers to it will be provided in class the following day. Also in class the following day, there will be a lab period with several skeletons available for you to learn the names of the bones and locate them.

Organ System:

1. Nervous -- Directly or indirectly regulates most other body systems; integrates and coordinates, and regulates external and internal changes of the body.

2. Endocrine -- Regulates body chemistry and structure via selective target-organ responses.

3. Muscle -- Movement of the body and its internal fluids, maintains posture, major source of heat production.

4. Cardiovascular -- Transportation system of the body. Brings functions and products (food and wastes) of all systems together.

   Circulatory

5. Lymphatic -- Cleans the body of wastes. Defends body against disease.

6. Respiratory System -- The respiratory system consists of air passages, the sinus, the trachea, small air tubes, and the lungs. The function of the respiratory system is primarily gas exchange. Exchange of oxygen from the air for carbon dioxide in the blood.

7. Digestive System -- This system consists of the G.I. tract (mouth, esophagus, stomach, small intestine, large intestine) and accessory organs. The digestive system breaks down food into smaller molecules and absorbs those molecules into the blood.

8. Urinary System -- The urinary system is composed of the kidney, ureter, urinary bladder and the urethrea. Its function is waste elimination and fluid regulation.

9. Reproductive System -- This system consists of internal reproductive organs and external structures called genetalia. Its function is reproduction and continuation of the species. (That's its biological function.)

10. Immune System -- This system is the body's main line of defense but it is still poorly understood. It consists of the thymus gland and many individual cells which produce antibodies.

11. Integumentary System -- This system is composed of the skin plus accessory structures. The function of this system is protection, body temperature regulation, and sensations.

12. Skeletal System -- This system consists of the body's bones. The skeletal system has several functions; protection, storage of minerals, support, and movement.

EXERCISE A

1. List and give the function of the twelve systems.

1.

2.

3.

4.

5

6.

7.

EXERCISE A (Continued)

8.

9.

10.

11.

12.

Part I -- Skeletal System (Figures 1 and 2)

Part A. The skeletal system consists of bones that are composed of the special connective tissue called bone. Bone tissue is predominately a hard calcified matrix with scattered cells called osteocytes. All bones are covered with a layer of tissue called periosteum and lined with a layer of tissue called the endosteum. These coverings and linings are composed of a specific type of connective tissue proper. Individual bones may be classified based on their shape and structure; long bones, flat bones, and irregular bones. All the bones of the skeletal system are joined together by joints or articulations which permit varying degrees of movement.

The skeletal system is subdivided into the axial system and the appendicular system. The axial system consists of the skull, vertebral column, hyoid bone, and the rib cage. The appendicular system includes the limbs, and bones they articulate with; the pectoral girdle and pelvic girdle.

EXERCISE B

1. Describe bone tissue.

2. Name the covering of bones and the lining of bones.

3. What are the three shapes of bones?

4. Define articulation.

5. What structures comprise the axial system?

6. What structures comprise the appendicular system?

Figure 1

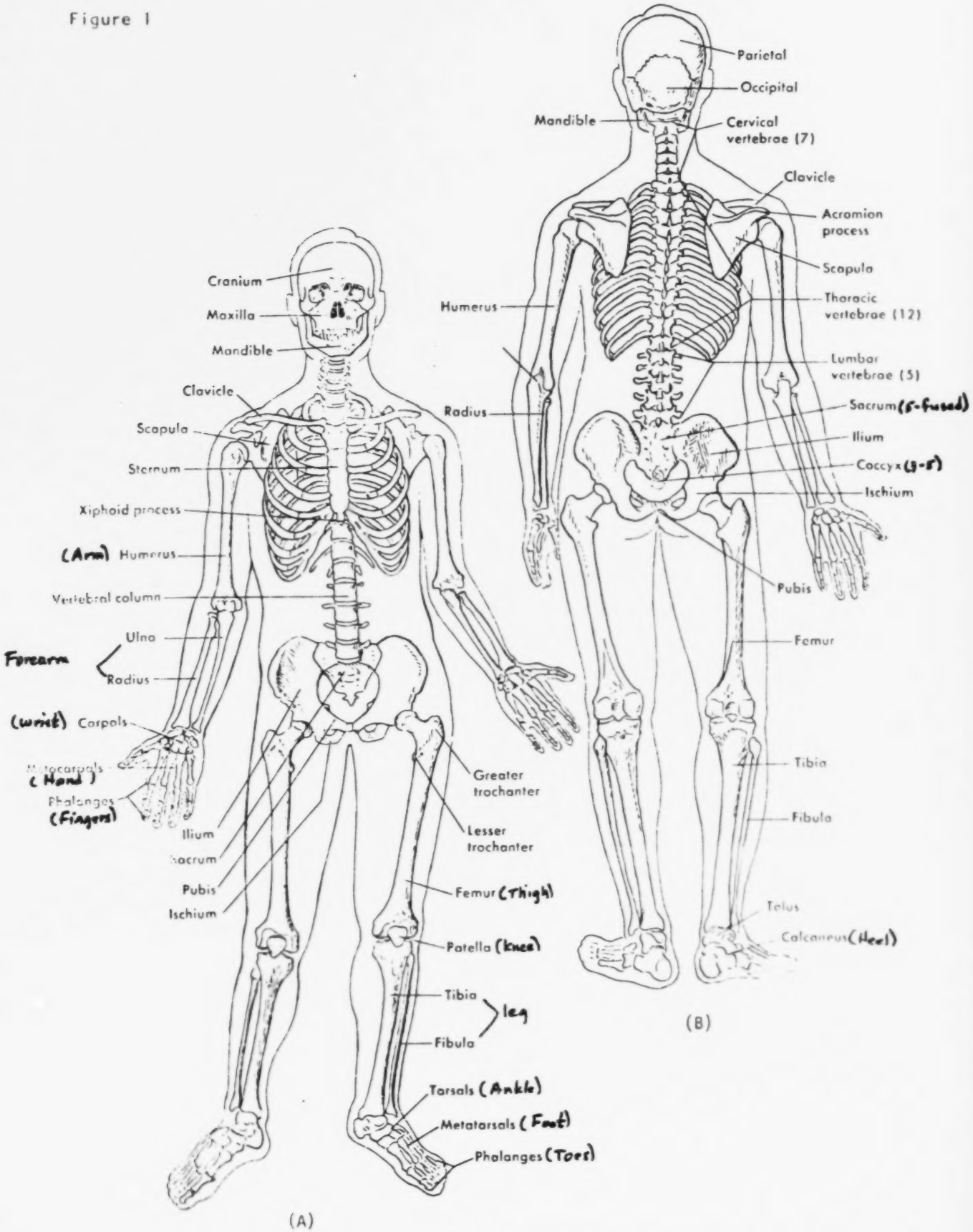
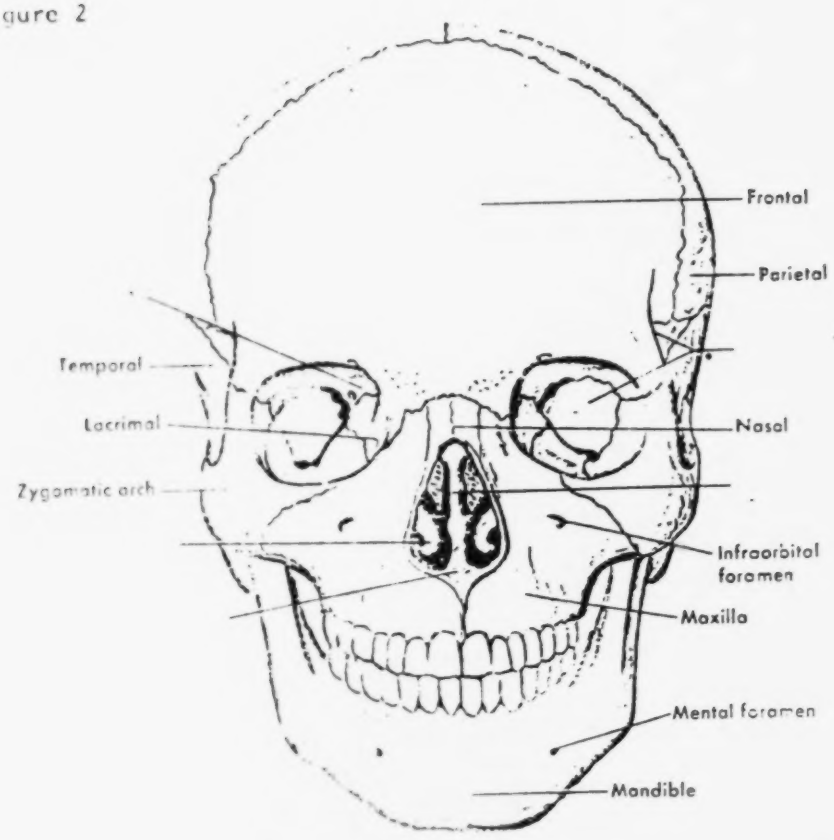

Cranium
Maxilla
Mandible
Clavicle
Scapula
Sternum
Xiphoid process
(Arm) Humerus
Vertebral column
Ulna
Forearm
Radius
(wrist) Carpals
Metacarpals
(Hand)
Phalanges
(Fingers)
Ilium
Sacrum
Pubis
Ischium
Greater trochanter
Lesser trochanter
Femur (Thigh)
Patella (knee)
Tibia
Fibula
leg
Tarsals (Ankle)
Metatarsals (Foot)
Phalanges (Toes)
(A)
Parietal
Occipital
Mandible
Cervical vertebrae (7)
Clavicle
Acromion process
Scapula
Humerus
Thoracic vertebrae (12)
Lumbar vertebrae (5)
Radius
Sacrum (5-fused)
Ilium
Coccyx (3-5)
Ischium
Pubis
Femur
Tibia
Fibula
Talus
Calcaneus (Heel)
(B)

Figure 2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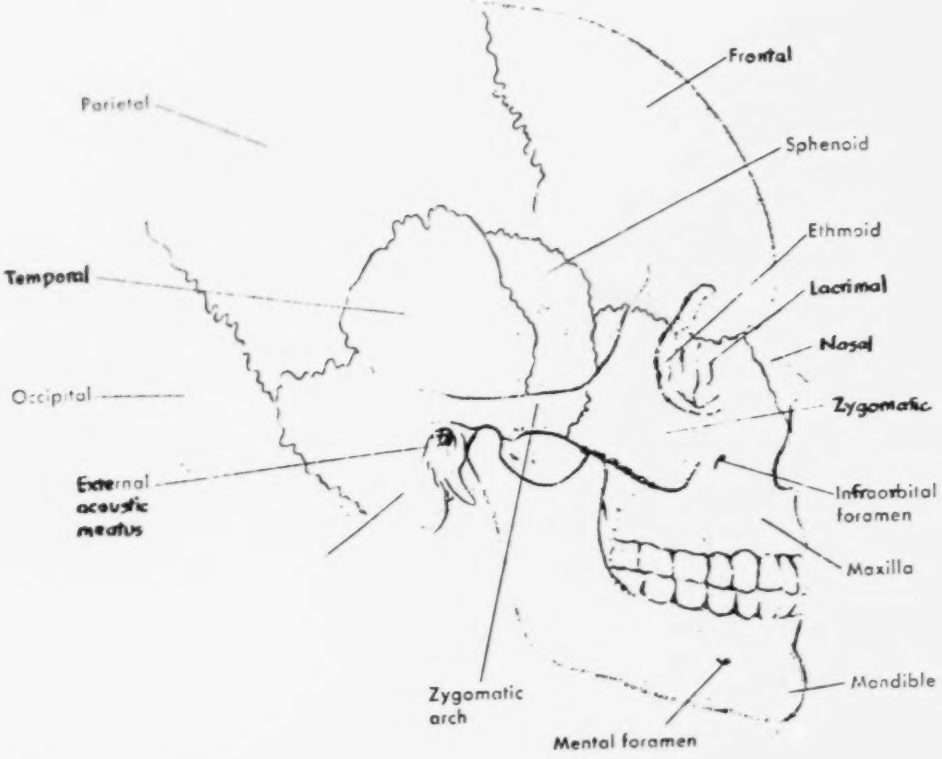
Parietal
Temporal
Lacrimal
Nasal
Zygomatic arch
Infraorbital foramen
Maxilla
Mental foramen
Mandible


Frontal
Parietal
Sphenoid
Ethmoid
Temporal
Lacrimal
Nasal
Occipital
Zygomatic
External acoustic meatus
Infraorbital foramen
Maxilla
Zygomatic arch
Mandible
Mental foramen

Part B. The Axial System

The skull is composed of flat and irregular bones. The skull consists of the cranium which protects the brain, and the bony portion of the face. The cranium (fig. 2) consists of one frontal bone, two parietal bones, two temporal bones, one occipital bone, one sphenoid bone, and one ethmoid bone (these two bones extend into the interior of the skull). The most prominate bones of the face are the mandible, maxilla, two zygomatic bones, two nasal bones, and several bones of the orbitals of the eyes. The skull has several small to large holes called foramem which permit passage of nerves and blood vessels.

The vertebral column (fig. 1b) or spine consists of 33 bones called vertebrae and it protects the spinal cord. The vertebrae are subdivided in five classes; cervicals of the neck, thoracics of the upper back, lumbars of the lower back, sacrals and coccygeals (caudal). The sacrals are fused into the sacrum, and the coccygeals (caudal) are fused into the coccyx ("tailbone").

The rib cage (fig. 1a) consists of twelve pairs of ribs and the sternum. it protects the organs of the chest cavity. Each rib is posteriorly attached to the thoracic vertebrae (fig. 1b) and ten pairs are directly attached anteriorly to the sternum. Pairs 8, 9, 10 are indirectly attached to the sternum. They, together with pairs 11, 12 are called false ribs. The inferior two pair of ribs are not attached to the sternum and are called floating false ribs.

EXERCISE C

1. Name the bones of the cranium.

2. Name the bones of the face.

EXERCISE C (Continued)

3. List the five classes of vertebrae.

Part C. The Appendicular Skeleton

The pectoral or shoulder girdle attaches the upper extremities to the axial skeleton. Each shoulder girdle consists anteriorly of the clavicle which is attached directly to the sternum. The scapula is the posterior bone of the pectoral girdle and is not attached to the axial skeleton. With only the clavicle attached to the axial skeleton, the shoulder exhibits an extremely wide range of motion. The upper extremities consist of the bones of the arm, forearm, wrist, hand, and fingers. The bone is the humerus, the ulna, and the radius make up the forearm. The hand is composed of carpals (wrist), the metacarpals (hand) and the phalanges (fingers).

The pelvic girdle or hip attaches the lower extremities to the axial skeleton and it protects the lower abdominal organs. Each half (right and left) of the pelvic girdle consists of three fused bones; the illium, the ischium, and the pubis. Posteriorly each illium is firmly attached to the sacrum and anteriorly the two pubic bones are attached firmly to each other. These firm attachments restrict the range of motion of the hip. The lower extremities consist of the thigh, leg, ankle, foot, and the toe bones. The thigh bone is the femur, the leg bones, tibia and the fibula. The foot is composed of the talus, the calcaneus, and other tarsals (ankle); metatarsals (foot); and the phalanges (toes). The pelvic girdle and the lower extremities support all the body weight of an individual and therefore, are the most massive bones of the body.

EXERCISE D

1. Name the bones of the pectoral girdle.

2. Name the bones of the upper extremity (limb).

3. Name the bones of the hand.

4. Name the bones of the pelvic girdle.

5. Name the bones of the lower extremity (limb).

6. Name the bones of the foot.

Answers to Exercises
Human Organ System Module

Exercise A

1. Nervous system -- coordination and regulation
2. Endocrine system -- coordination and regulation
3. Muscle system -- movement and heat generation
4. Cardiovascular system -- deliver important substance and carry away waste products
5. Lymphatic system -- cleans and limited defense
6. Respiratory system -- gas exchange
7. Digestive system -- breakdown and absorption of food
8. Urinary system -- waste elimination and fluid regulation
9. Reproductive system -- reproduction
10. Immune system -- defense
11. Integumentary system -- protection, heat regulation, sensation
12. Skeletal system -- protection, mineral storage, support and movement

Exercise B

1. Bone tissue is composed of hard calcified matrix and osteocyte
2. Periosteum and endosteum
3. Long, flat, irregular
4. A joint, area where bones join together
5. Skull, spine and rib cage
6. Shoulder girdle, pelvic girdle, upper and lower limbs

Answers to Exercises
Human Organ System Module

Exercise C

1. Frontal, temporal, parietal, occipital, sphenoid, ethmoid
2. Mandible, maxilla, zygomatic, nasal
3. Cervical, thoracic, lumbar, sacral, coccygeal

Exercise D

1. Scapula and clavicle
2. Humerus, ulna, radius
3. Carpals, metacarpals, phalanges
4. Illium, ischium, pubis
5. Femur, tibia, fibula
6. Talus, calcaneus, tarsals, metatarsals, phalanges

Self Test -- Human Organ System Module

1. Label the diagram of the skull
2. Label the diagram of the skeleton.

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